

Career and Technical Education as a Conduit for Skilled Technical Careers: A Targeted Research Review and Framework for Future Research

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RESEARCH REPORT

Career and Technical Education as a Conduit for Skilled Technical Careers: A Targeted Research Review and Framework for Future Research

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Workforce development and career and technical education (CTE) have long provided reliable pathways to middle skill jobs and a gateway to the middle class. Given recent changes in middle skills jobs, the education landscape, and federal policy priorities, the role of CTE in the U.S. educational landscape is evolving more rapidly, encompassing a broader range of education, and practices are changing ahead of research. The first part of this report provides an overview of the current state of CTE in the United States, as well as the state of CTE research, and presents an argument for a broader definition of CTE that incorporates workforce development through postsecondary institutions. The second part provides operational definitions and typologies to facilitate future research. Our aim is to build a research framework for CTE that is grounded in a normative path through CTE: getting in (preparation and recruitment), getting through (retention and skill acquisition), getting out (completion and initial hire), and getting on (career progression). Key challenges and priorities for future research are discussed.

Keywords Career and technical education; vocational education; workforce development; skill development for the new economy; high schools; community college; career pathways

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Skills and employment are inherently linked, affecting the economic well-being of individuals and the economy at large (Kirsch & Braun, 2016). Efforts to reduce inequalities often focus on workforce development, instilling in-demand skills in workers as part of an effort to improve access to good jobs¹ to help individuals move up into the middle class. However, the type of skills required for jobs that enable individuals to reach and maintain middle-class status are ever evolving. The increasing pace of innovation, automation, and globalization influences the nature of work, and employers demand a more highly educated and skilled workforce for even entry level jobs. Previous pathways to the middle class that featured low barriers to entry have been disrupted. Examples include the traditional blue-collar factory worker whose job stability has eroded in the postindustrial economy, and the white-collar clerical worker whose job stability has eroded in the digital information age (Carnevale et al., 2016).

Despite setbacks in traditional pathways to the middle class, new pathways are emerging. New middle-skill jobs and innovations in training aligned to labor market demands have improved job prospects for workers who have some postsecondary education, but no bachelor's degree (Carnevale et al., 2018). In particular, emerging forms of *skilled technical work*, including skilled blue-collar and skilled service jobs, have provided good opportunities for individuals in this educational space. Skilled technical work occupies the space between low-paid service occupations and professional occupations, where jobs require a high level of knowledge in a job-specific and/or technical domain (Rothwell, 2015). Skilled technical jobs are found across a range of industries whose skill demands have increased or have become specialized due to technological advances and improved processes; health care, advanced manufacturing, transportation and logistics, retail, and professional services are all affected (National Academies of Sciences, Engineering and Medicine, 2017).

While skilled technical work requires training, it features lower barriers to entry than a bachelor's degree, making it an appealing route for individuals seeking a quicker path to paid employment. Workforce development systems work to build routes to these jobs that can help propel high school graduates and provide postsecondary training opportunities that address significant gaps in earnings and reduced career mobility. Increasingly, workforce development is happening in community colleges, which are responding to increasing skill demands from the workforce by shifting their focus from

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being transfer-only institutions to encompass locally driven programs that blend work-based and classroom learning (Jacobs & Worth, 2019). This extends the reach of career and technical education (CTE), a term applied to schools, institutions, and educational programs that specialize in the skilled trades, applied sciences, modern technologies, and career preparation (Great Schools Partnership, 2014), which has historically been associated with secondary education but increasingly has a home in postsecondary institutions as well. CTE represents a crucial pathway for many underserved and underemployed learners, whether as part of a high school curriculum, for high school graduates seeking postsecondary training and certification, or for adult workers being retrained or entering the workforce for the first time (Bragg et al., 2006). Currently, more than 12.5 million high school and college students are enrolled in CTE programs (Advance CTE, n.d.).

CTE has attracted national attention in recent years as an educational pathway with great potential to help both workers and employers. This awareness has led to an increasing pace of reforms and innovations. Encouraged by federal programs such as the Workforce Innovation and Opportunity Act (WIOA), Trade Adjustment Act for Community College and Career Training (TAACCCT) grant program, the Strengthening Career and Technical Education for the 21st Century Act, and the addition of a CTE topic line in the Institute for Education Sciences' (IES) Education Research Grants Program, policymakers and schools have developed increasingly sophisticated models of CTE delivery, which increasingly occur in both secondary and postsecondary institutions. However, the diversity of program offerings and outcomes is a great challenge for research, as practices are evolving more quickly than CTE research (Alfeld, 2016).

Given the importance of CTE and the urgency of expanding its research basis, we believe that a framework is needed to serve as the foundation for future research in this field and to introduce more consistency in operational concepts. Recognizing the importance of high school and postsecondary CTE as a conduit for learners to compete for and succeed in obtaining skilled technical jobs that result in entering meaningful career paths (National Academies of Sciences, Engineering and Medicine, 2017), this report establishes a framework for future research on this important educational and career path. We begin with an overview of the current state of skill acquisition in the United States, operationalizing terms that are often treated ambiguously in practice and in the literature. We argue for a broader definition of CTE, which encompasses what many traditionally think of as workforce development, as these programs grow in scope and sophistication. The second part of this report provides typologies to facilitate future research, as well as a research framework for CTE grounded in a normative path through CTE. This normative path examines how students and adults successfully enter and progress in skilled technical work through the conduit of CTE. Specifically, there is a need to understand: (a) the decision-making mechanisms by which learners consider embarking on and successfully *enter* CTE training, (b) the effective strategies to teach essential job skills required to *persist* in their programs and *complete* training, as well as the contextual factors that support (or hinder) successful completion, and (c) the factors associated with *obtaining skilled technical jobs* upon graduation, and (d) the long-term prospects for these students as they *advance along skilled technical career paths*. In other words, we frame our research in terms of the CTE pathway, from entrance through occupational attainment and success, focusing on students' experiences with CTE: getting in to the CTE pathway, getting through a CTE program, getting out of the CTE program, and getting on with a career in the CTE spaces for which they have trained.

Defining CTE: Programs, Pathways, and Students

CTE is a broad concept that has a variety of working definitions and related notions and is often known by other terms (e.g., vocational education and training, technical education, middle skills education). Given the broad variation in CTE and vocational education domestically and internationally, we have focused our efforts on U.S. structures and literature.

Education and vocation have long been intertwined; in fact, the roots of CTE in the United States predate its founding. However, vocational education has been receiving federal investment only for just over a century, starting with the Smith-Hughes National Vocational Education Act of 1917, which was initially limited to secondary schools (Jacobs & Worth, 2019). Federal funding shifted to the Vocational Education Act in 1963, which expanded the menu of occupational paths and offered funding for area vocational schools; in its 1968 amendment, it included community colleges (Friedel, 2011). Over the past 35 years, U.S. federal funding for vocational education has primarily moved through the Perkins Act (which began as the Carl D. Perkins Vocational Education Act of 1984 and has evolved through multiple iterations to today's Strengthening Career and Technical Education for the 21st Century Act, more commonly known

as Perkins V). The term CTE replaced the term *vocational education* in the Carl D. Perkins Career and Technical Education Act of 2006, or Perkins IV (Association for Career and Technical Education et al., n.d.). The current iteration of Perkins, the Strengthening Career and Technical Education for the 21st Century Act (2018) or Perkins V, defined CTE in its original House Resolution 5,587 (later amended to House Resolution 2,353 and then published as public law) as:

The term “career and technical education” means organized educational activities that

(A) offer a sequence of courses that—

(i) provides individuals with rigorous academic content and relevant technical knowledge and skills needed to prepare for further education and careers in current or emerging professions, which may include high-skill, high-wage, or in-demand industry sectors or occupations, which shall be, at the secondary level, aligned with the challenging State academic standards adopted by a State under section 1111(b)(1) of the Elementary and Secondary Education Act of 1965;

(ii) provides technical skill proficiency or a recognized postsecondary credential, which may include an industry-recognized credential, a certificate, or an associate degree; and.

(iii) may include prerequisite courses (other than a remedial course) that meet the requirements of this subparagraph;

(B) include competency-based, work-based, or other applied learning that supports the development of academic knowledge, higher-order reasoning and problem-solving skills, work attitudes, employability skills, technical skills, and occupation-specific skills, and knowledge of all aspects of an industry, including entrepreneurship, of an individual;

(C) to the extent practicable, coordinate between secondary and postsecondary education programs through programs of study, which may include coordination through articulation agreements, early college high school programs, dual or concurrent enrollment program opportunities, or other credit transfer agreements that provide postsecondary credit or advanced standing; and.

(D) may include career exploration at the high school level or as early as the middle grades (as such term is defined in section 8101 of the Elementary and Secondary Education Act of 1965).

With the historical changes in federal funding, it is increasingly recognized that CTE is not only the milieu of secondary schools but has entered into the postsecondary space as well, often in the community college landscape, supporting a more expansive research definition of CTE. It is becoming a foundational mission of community colleges today (O’Banion, 2019).

The broader concept of CTE has several strands that merit consideration and formal definition. In particular, we discuss the concepts of CTE programs, pathways, and how to define CTE students.

CTE Programs

As presented above, Perkins V outlines outcomes associated with CTE: the acquisition of a skill, an industry-recognized credential, a certificate, or an associate’s degree. These outcomes are achieved through secondary (e.g., high school/technical high school) or postsecondary institutions (e.g., community college or for-profit training centers), and Perkins V even encourages career exploration as early as middle school. As such, they prepare for jobs that the U.S. Department of Labor has classified as Zone 2 or Zone 3 in their O*NET classification of jobs (see <https://www.onetonline.org/help/online/zones>). Zone 2 jobs require some preparation, typically require a high school diploma and some work-related skill or experience, while Zone 3 jobs require medium preparation such as vocational school training or an associate’s degree. Even though CTE programs are often embedded in institutions that offer traditional diplomas or degrees, they are delivered through vocational coursework that is intended to instill more specialized, job-ready skills than the traditional high school diploma or college degree. CTE coursework can occur within noncredit and business programs in community colleges, but it can also occur within credit programs in the arts and sciences (e.g., biology, art departments). CTE programs often incorporate on-the-job training as well, such as internships and apprenticeships. CTE programs prepare students for entry into any of the 16 career clusters identified in the National Career Clusters Framework² (<https://careertech.org/career-clusters>— for a complete list of 79 CTE-related pathways within these clusters, see Appendix A).

High School/Secondary CTE

High school/secondary CTE is composed of both *occupational coursework* that prepares individuals for specific careers and *nonoccupational coursework* that offers more general work-related skills such as computer literacy that span occupations (Dortch, 2014). It can be embedded within traditional high schools, or some areas offer it through technical high schools. Full-time, occupational high school CTE students often are more oriented toward their chosen career path than toward furthering their education, thus being less likely to take college preparatory curriculum including 4 years of English and 3 years of science, social studies, and mathematics (ACT, 2015; Stone & Aliaga, 2005). Many high school or secondary CTE programs are geared toward some form of professional credentialing, such as a certificate or preparation for licensure.

Postsecondary CTE

Postsecondary CTE offers a higher education credential that is a practical option for creating meaningful and well-paid careers (Carnevale et al., 2012). Postsecondary CTE is typically offered by community colleges and proprietary schools, which provide postsecondary certification and training programs as a vehicle for preparing individuals seeking skilled technical work. A student can seek a certification, which often does not include general education requirements, in areas such as advanced manufacturing or cybersecurity or as a health technician. A student might also seek a 2-year associate's degree (e.g., associate of applied science) that combines some general education, career-specific training, and real-world practice and internship. For example, allied health is a popular field that promotes an integrated academic and career-focused training. Roughly one third of community college students will transfer within 6 years of first matriculation to pursue 4-year degrees (Shapiro et al., 2017).

Hands-on training such as internships, externships, practicum, and apprenticeships are often an integral component of the CTE experience. Whether studying for the trades (e.g., construction, electric, HVAC, plumbing), allied health care (e.g., radiology technician, medical coder, dental hygienist), advanced manufacturing (e.g., machinist, production supervisor, line worker), or information technology (e.g., network support technician, computer support specialist, database administrator), the work-based learning offered through CTE programs serve as a direct link between education and employment for students. Work-based learning is an opportunity for businesses to directly train their workforce and a chance for students to earn money while they learn (U.S. Department of Labor, n.d.). This kind of opportunity is also a pedagogical tool with great growth potential; funding concerns, applicants' logistical challenges, and lack of expertise have often prevented employers from taking on interns and apprentices, but businesses are beginning to understand the critical role apprenticeships can play in developing work-ready candidates (Kantrov, 2014). There is growing federal interest in apprenticeship as well, as Perkins V expanded its interest in work-based learning strategies. Federally registered apprenticeships have proven beneficial, as a 2012 report by Mathematica demonstrated increased annual earnings for registered apprentices versus comparable nonparticipants (Reed et al., 2012), which is promising for future support for work-based learning.

Increasingly, there are calls to bridge secondary and postsecondary CTE. The Office of Career, Technical, and Adult Education (OCTAE) in the U.S. Department of Education encourages a program of study design framework that offers more exploratory CTE coursework in secondary school, leading to more occupational skills-driven CTE coursework and a credential in postsecondary school (Perkins Collaborative Research Network, n.d.). This arrangement requires formal partnerships between educational institutions and local employers.

In short, CTE programs instill work-ready skills in the educational space between a traditional high school diploma and a traditional bachelor's degree, though these programs can be springboards for further higher education. Though there may be some general education embedded in a CTE program, nearly all the energy and focus of the program is on skills that will translate directly to jobs that require more specific occupational training than a general high school education. Moreover, it will do so in ways that are more applied and require less time than a traditional bachelor's degree and that can be acquired through a mix of classroom-based and workplace-based training.

CTE Pathways

Many CTE programs are part of the middle-skills pathway, one of three educational pathways described by the Georgetown University Center on Education and the Workforce (Carnevale et al., 2018): (a) the high school pathway (workers

with a high school diploma or less), (b) the middle-skills pathway (workers with more than a high school diploma but less than a bachelor's degree, including those with associate's degrees, postsecondary certificates, licenses, and certifications), and (c) the bachelor's degree pathway (workers with a bachelor's degree or higher). This conceptualization of pathways is related to points of entry into the workforce, and the education levels students achieve to land that first job. However, community colleges have begun to implement pathway models that encourage lifelong learning. While the CTE student's education may begin with a subbachelor's degree or certificate program, it is important to note that it does not necessarily end there. The *career pathways* movement is conceptualizing pathways not only as on-ramps to first jobs, but rather developing roadmaps to help students build careers over the course of years and even decades, upgrading skills and upgrading jobs along the way. These innovations are a response to increasing employer skill demands and a push to increase the levels of education and credentialing of the U.S. population (Jacobs & Worth, 2019). Career pathways, which align different levels of education with employment, are designed to allow students multiple exit and entry points in education, often including CTE as part of a longer career and education trajectory (Bragg et al., 2017). The career pathways model has been supported by three major federal laws and funding streams: WIOA, the Higher Education Act (HEA), and Perkins V; furthermore, it was a priority of the TAACCCT grant program (Mortrude, 2018).

To facilitate further education, some community colleges are developing stronger noncredit to credit pathways that smooth the way for CTE students with certificates who are seeking further education such as bachelor's degrees and beyond (Mortrude, 2018). For example, community colleges may map pathways that provide opportunities for students to stack credentials that begin with a certificate program for nursing assistants, allowing students reasonably quick entry into the paid workforce. This strategy may build toward an associate's degree program for registered nursing, which may in turn build toward a bachelor's degree program for registered nursing, and which builds toward a master's degree program for a nurse practitioner or physician assistant. Along the way students can support themselves and build careers with increasing pay and responsibilities as their education levels increase.

Some community colleges are also working to internalize the educational pathway, which can smooth program transfers along the pathway and reduce credit loss between levels. In particular, the expansion of applied baccalaureate programs in the community college system (Bragg, 2019) is changing the nature of college to include more options for college degrees that build on CTE education, infusing 4-year degrees with technical skills that employers demand.

CTE Students

Having clarified the programmatic and pathway definitions of CTE, we turn our attention to another important factor to consider in research design: What counts as a CTE student? CTE is an educational pathway where committed CTE students are often studying alongside students who are just trying out a class or two for personal enrichment or exploration, as CTE classes typically have open enrollment or at least few requirements for admission and include some categories that can be pursued for general interest or hobbies. Therefore, in assessing student outcomes and program efficacy, it is important to be clear about who is truly engaged in CTE and who is merely dabbling, for the educational and career pathways of these students can vary broadly and skew results.

Thus far, the primary strategy to identify the truly engaged students has been to differentiate students by levels of CTE course participation. For example, Perkins V identifies two class of CTE students: CTE concentrators and CTE participants (Strengthening Career and Technical Education for the 21st Century Act, 2018). This is a critical distinction, as it is a key change in Perkins V and affects how state-adjusted levels of CTE performance are determined, which has implications for program funding. CTE concentrators are defined by Perkins as students at the secondary level who have completed three or more CTE courses or have completed at least two courses in a single CTE program or program of study. At the postsecondary level, CTE concentrators are defined as students who have earned at least 12 credits within a CTE program or program of study or completed an entire CTE program if the program itself consisted of fewer than 12 credits. In contrast, CTE participants are students who complete at least one CTE course or earn at least one CTE credit (Strengthening Career and Technical Education for the 21st Century Act, 2017–2018).

These Perkins V definitions are somewhat contested, as researchers have used slightly different measures over the years. One prime example comes from Dalton et al. (2013), adopted by the Association for Career and Technical Education (ACTE), the Advance CTE network, and National Alliance for Partnerships in Equity (NAPE), and referred to as the *research model* (Association for Career and Technical Education et al., n.d.). The research model distinguishes between two broad classes of CTE students based on how many occupational credits³ they hold, and each class has two subcategories:

(a) *noninvestors* (including *nonparticipants*, who had earned less than one occupational credit, and *samplers*, who had earned one or two credits), and (b) *investors* (including *explorers*, who had three or more occupational credits but no one occupational area with three or more credits, and *concentrators*, who had three or more occupational credits in a single occupational area).⁴

Adding to the confusion is the fact that different states follow different definitions to distinguish their own concentrator populations of CTE students. According to data from the National Center for Education Statistics (NCES), compiled by the ACTE/Advance CTE/NAPE collaborative, there are at least three definitions of CTE concentrators actively used by different states, none of which are used by the majority of states (Association for Career and Technical Education et al., n.d.).

In principle, the Perkins V *CTE concentrator* is the equivalent of the combined *investor* category in the research model: It includes both *explorers* (who may be trying a variety of programs on) and *concentrators* (who are more clearly attempting to complete a CTE program), while the Perkins V *CTE participant* is equivalent to the research model's *sampler*. However, there is a richness to the research model that is lost in a two-category Perkins system, and there are qualitative differences between CTE explorers and CTE concentrators. While the Perkins V definitions are likely sufficient for regulatory use, the research model offers a preferable typology of CTE student engagement for any effort to study CTE education and is the model that ETS uses.

It is also important to note that CTE students can and do follow traditional pathways from high school CTE into postsecondary CTE or CTE employment, but CTE is also a pathway for adults who are unemployed or reskilling. CTE programs in community colleges serve these individuals with programs that can be completed in 2 years or less. Having defined CTE in terms of programs, pathways, and students, it is important to understand what CTE can accomplish and why it is such a critical tool for addressing economic and educational challenges.

CTE as a Response to Economic and Educational Challenges

CTE historically was viewed as a reliable first step on the pathway into the middle class,⁵ which was largely composed of semiprofessionals and craftsmen who had some work autonomy and typically, some postsecondary training (Thompson & Hickey, 2005). Typical middle-class jobs once included manufacturing, automotive, hospitality, or other applied occupations and industries. CTE could qualify workers for entry-level jobs in these fields, and firm internal labor markets offered job ladders that the workers could climb.

Increasing automation, technology, and skilled labor expectations has reduced the number of livable wage jobs someone limited to high school or less can obtain, and the recent uptick in interest in CTE corresponds with declining labor market opportunities for individuals with high school diplomas only (referred to as *diploma workers*). According to projections by the U.S. Bureau of Labor Statistics, between 2016 and 2026 there will be above average growth in occupations that require postsecondary credentials, while those that do not require postsecondary credentials will see only modest gains (Rolen, 2019). The average projected growth across all occupations for that time period is 7.4%; jobs with entry-level requirements of postsecondary nondegree awards and associate's degrees are projected to grow at 11.1% and 11.0%, respectively, while jobs with high school diplomas or equivalents, or some college but no degree, have projected growth of 5.1% and 4.2%, respectively (Rolen, 2019). Furthermore, the quality of available jobs is eroding for these workers. Between 2010 and 2016, diploma workers lost 181,000 high-skill jobs and 951,000 middle-skill jobs, while adding 1.2 million low-skill jobs (Carnevale et al., 2016). As the prospects for diploma workers decline, the pathway from CTE to skilled technical work offers an alternative to diploma-only work that requires less time in education/training and fewer resources than traditional academic pathways through postsecondary education.

Meeting the Challenges of the 21st Century: Increasing Credential Holdings in the U.S. Population

Education and training are critical not only for individuals' economic prospects but also to maintain a thriving economy. Unfortunately, a significant portion of our young adults do not meet essential skill thresholds required for a 21st century workforce (Nettles, 2017). In recent years, there has been a variety of efforts to improve the skills of the U.S. workforce, as the expansion of postsecondary educational opportunities was the subject of two major policy initiatives launched in 2009 when the incoming Obama administration introduced a goal of the United States having the highest proportion of college graduates in the world by 2020 (Marcus, 2019); soon thereafter, the Lumina Foundation introduced the ambitious

60-by-25 initiative, which aimed to increase the percentage of Americans holding college degrees or high-quality credentials to 60% by the year 2025 (up from the rate of 39% in 2009; Lumina Foundation, 2019). These goals and accompanying funding streams have influenced the thinking of educational leaders and state policymakers, and many strides have been made toward these goals. These calls were also very ambitious and difficult to reach without innovations in education delivery. Obama's 2020 goal is particularly challenging because it relies on traditional pathways to college degrees; there have been many great strides, but while statistics are not yet available for 2020, in the 2015 OECD statistics, the United States was still ranked only 10th among OECD countries in college attainment, up from 15th in 2010 (Fry, 2017). It appears unlikely that the United States will reach the top by the time of data collection this year.

The Lumina 2025 goal is currently more plausible, as it recognizes high-quality credentials as valuable alternatives to traditional college degrees, an acknowledgement that CTE is an economic and feasible way to help close the gap in post-secondary education (Lumina Foundation, 2019). Currently the CTE infrastructure is extensive; about 67% of public high schools offer CTE programs and nearly all of the nation's 1,020 public 2-year colleges offer CTE programs (U.S. Department of Education Office of Career, Technical, and Adult Education, & The National Center for Innovation in Career and Technical Education, 2016). About 50% of public 4-year institutions also offer subbaccalaureate CTE certificates and degrees. In addition, over 40% of the nation's for-profit 4-year institutions and 95% of the for-profit 2-year colleges offer subbaccalaureate credentials, which are typically in CTE programs (U.S. Department of Education Office of Career, Technical, and Adult Education, & The National Center for Innovation in Career and Technical Education, 2016). CTE is also very cost-effective; the cost per secondary student participating in CTE is as low as \$72.40, compared to such cost per postsecondary student of \$128.70 (U.S. Department of Education Office of Career, Technical, and Adult Education, & The National Center for Innovation in Career and Technical Education, 2016). Given the prevalence of CTE programs and their low costs, CTE programs that lead to certificates or licensure offer practical and efficient solutions to building a more educated and credentialed workforce.

There is increased demand from workers, employers, and policymakers alike to improve the educational attainment of the U.S. population, which can be accomplished in part by engaging and advancing historically underserved and disadvantaged learners. Given CTE's practicality and broad appeal, it is notable if not surprising that there is bipartisan support for CTE training and apprenticeship programs, witnessed by the recent approval of Perkins V.

The CTE Research Mandate

Despite the growing interest in, and funding for, CTE programs, CTE has not received nearly the same research attention as traditional K-12 and postsecondary programs. There is limited data on a variety of critical educational issues as applied to CTE, including themes such as what CTE graduates are learning, how high school course sequences affect outcomes, and the impact of CTE training on longer term career mobility and progression, as we will discuss below. We have limited information on differences in the level of performance among subgroups in CTE, in contrast to our knowledge of the same in traditional academic programs and assessments. This was recently highlighted by a Brookings policy report (Jacob, 2017) that reviewed the IES *What Works Clearinghouse* and found only one experimental or quasi-experimental study on CTE, from the early 1990s, in comparison to the 83 experimental studies in early childhood education, 39 for dropout-prevention, and 32 for English language learners. Experimental and quasi-experimental studies in CTE are less prevalent and less likely to make it into the annals of this widely used educational database.

In a recent IES-sponsored technical working group on CTE, a panel of experts examined our current knowledge base and identified critical research gaps in relation to CTE (Ahn, 2017). The need to conduct research on the impact of CTE on vulnerable populations and to dispel the myth that CTE is a means to track and hold back students was among the points of emphasis. This situation has implications for educational access and equity, and as CTE is so directly linked with the world of work, it may have major implications for workplace access and equity as well.

To date, the research basis for evaluating CTE short- and long-term outcomes is limited almost exclusively to nonexperimental research and descriptive field studies (Dougherty & Lombardi, 2016; Jacob, 2017). There have been some analyses of national data sets to the study of CTE (cf. Bozick & Dalton, 2013; Plank et al., 2008; Wagner et al., 2016), though generally speaking, statewide data sets have had broader use in CTE research (cf. Dougherty & Zeehandelaar, 2017; Jacobson & Mokher, 2014; Stevens et al., 2018). Given the variety of CTE standards across the country, statewide datasets can provide important insights into CTE trends and outcomes; in fact, the IES-sponsored technical working group on

CTE encouraged the use of state and industry datasets to better understand how to bridge the divide between high school and college CTE, and workplace access and success (Ahn, 2017).

Finally, the IES panel noted the need to conduct research on transition points, focusing on the factors that influence positive transitions through secondary to postsecondary school, work, and the choices to enter various career pathways (Ahn, 2017). Given this suggested focus, a research framework for CTE can help to delineate these transitions and attune researchers to the broader pathways and ecosystems in which students experience CTE.

The ETS Research Framework for CTE: An Inclusive Model for a Complex System

Establishing a research framework for CTE is a challenge, as CTE is a rapidly evolving category of education and training, encompassing a broad variety of programs, careers, and students. For example, among the many continuums and variants, programs can be embedded in K-12 or beyond; public or private; and designed to be completed in timeframes that are very short or somewhat lengthy. Careers can be in long-established jobs (e.g., legal assistant) or in newly emerging ones (e.g., cybersecurity), in highly regulated jobs (e.g., most allied health fields) or in ones devoid of a regulatory frame (e.g., most advanced manufacturing), and in jobs where one could flourish for decades until retirement (e.g., medical records) or in ones that are physically demanding and difficult to hold for many years (e.g., certified nursing assistant). Students can arrive at CTE from sending institutions (i.e., prior schools) well-prepared for their coursework, or underprepared. They can be well-informed about their chosen path and alternatives, or have little idea about either. They also vary in levels of personal support (e.g., finances, family supports) or personal responsibilities (e.g., parenthood, head of household responsibilities).

The research framework presented in this paper was developed in iterations based on a formal review of the CTE literature. The prototype theoretical framework is a three-part pathway grounded in the IES CTE working group recommendations and based on an initial assessment of the literature by the research team. The framework describes the process of entering CTE programs (getting in), persisting through them (getting through), and ultimately graduating and placing in CTE-related jobs (getting out); it features subsets of issues associated with each step in a normative CTE pathway. The research team conducted a formal literature review that examined the three major educational components of the research model (getting in, getting through, and getting out) by associated issues, with separate searches for both secondary and postsecondary education to determine the extent to which previous literature addressed, or failed to address, the areas examined in the framework. The goal was to develop a typology of the literature by categories according to the three “getting” components of our initial framework, providing exemplary citations to serve as a snapshot in time of the state of the research for each stage of the CTE pathway. For example, in the high school getting in section, three issues were highlighted (student choice, concentration and nonconcentration, and course concentration). The research team worked with the EBSCO thesaurus to determine search terms and parameters that would capture a broad range of peer-reviewed articles. Upon finalizing terms, the literature search began with secondary CTE (high school-based), which was then replicated with postsecondary institutions. Appendix B features the search terms used in the initial high school searches.

The resulting literature was cleaned (duplicates removed) and coded based on relevance, with 1-Having no relevance to the original model themes to 3-Very relevant to the original model themes. Finally, articles from the very relevant category were selected if they had a national or state representative sample, included a rigorous methodology, and provided insight for the category of interest. These articles were selected for a model-based literature table, with no more than 10 articles per category. While it was not an exhaustive representation of the CTE literature, it was a structured snapshot of work in the field (see Appendix C for the resulting table).

This process illuminated how exceedingly difficult it could be to place many articles into a single category—some items were both getting in and getting through, or getting through and getting out, or even getting in and getting out; many items could be placed in several buckets, and efforts to distinguish them only highlighted how interrelated the categories were. Furthermore, precursor factors such as demographics and family background were not represented by the model, and several articles pointed to workforce outcomes beyond initial hire. While the model accurately captured the pathway within CTE programs from beginning to end, given the role of precursor factors in the program experience and the direct connection between CTE and employment, it was clear that the model would be more useful if it captured these factors as well. The model was therefore refined to extend beyond CTE education, incorporating precursor routes to CTE, and extending into the jobs and careers for which CTE serves as preparation. Given the focus in the IES recommendations on transitions and the evident interconnected nature of those transitions, the CTE research framework can be usefully

rooted in a social pathway (Elder Jr. et al., 2003, p. 8) as conceptualized in the life course theoretical perspective. The life course perspective reminds us to consider five principles in research:

1. Human development and aging is a lifelong process
2. Individuals have agency in constructing their path within a set of historical and social circumstances
3. Historical time and place structure experience
4. Timing of events and transitions in one’s life affect how they are experienced
5. Lives are linked and these linkages affect one’s experiences (Elder Jr. et al., 2003)

A life course perspective is useful in education research because it can help us understand the broader context in which educational pathways operate (Crosnoe & Benner, 2015). As applied to education, the life course perspective reminds us that individuals are ever learning and adapting, and to consider the time and place in which students operate (e.g., state, policy, and economic contexts, as well as employer demands and workforce trends), the role of networks and institutions (e.g., access to information in decision-making, preparation from sending institutions), and the role of personal timing (e.g., traditional students, returning adult students) in shaping the educational experience. Individuals have agency, but that agency is constrained by the context in which they live and the information available to them to make decisions. Additionally, we must consider the effects of cumulative advantages and disadvantages (i.e., how resource abundance or shortages tend to compound over time; DiPrete & Eirich, 2006), which can influence one’s experience in education. Finally, grounding our work in a life course approach offers rich insight into the trajectories and pathways that make up the educational experience, as well as the transitions and turning points that change those trajectories (Pallas, 2003). These insights are quite beneficial as scholars consider factors that help people to enter and persist in educational programs and factors that cause roadblocks along the way. By integrating the life course perspective, the CTE research framework is sensitive to the way that institutions and life transitions affect individual experiences and outcomes in education and work.

As we have suggested earlier, in order to create a more universal model that can encompass this broad variation, we have focused on the path through a typical CTE program, identifying issues related to four key moments in progression along the path: (a) getting in (preparation and recruitment), (b) getting through (retention and learning), (c) getting out (program completion), and (d) getting on (hiring and career progression). This framework is represented in Figure 1. The student routes to CTE, getting in and getting through, represent inputs and activities for students and CTE programs, while getting out and getting on represent short- and long-term outcomes. Multiple levels of factors are acting on the student and system to influence outcomes along the CTE pathway. Therefore, our model is designed to represent individual/student-level factors, CTE program factors, and factors associated with the broader ecosystems in which CTE programs operate (e.g., sending institutions, local employers and economies, policy environments).

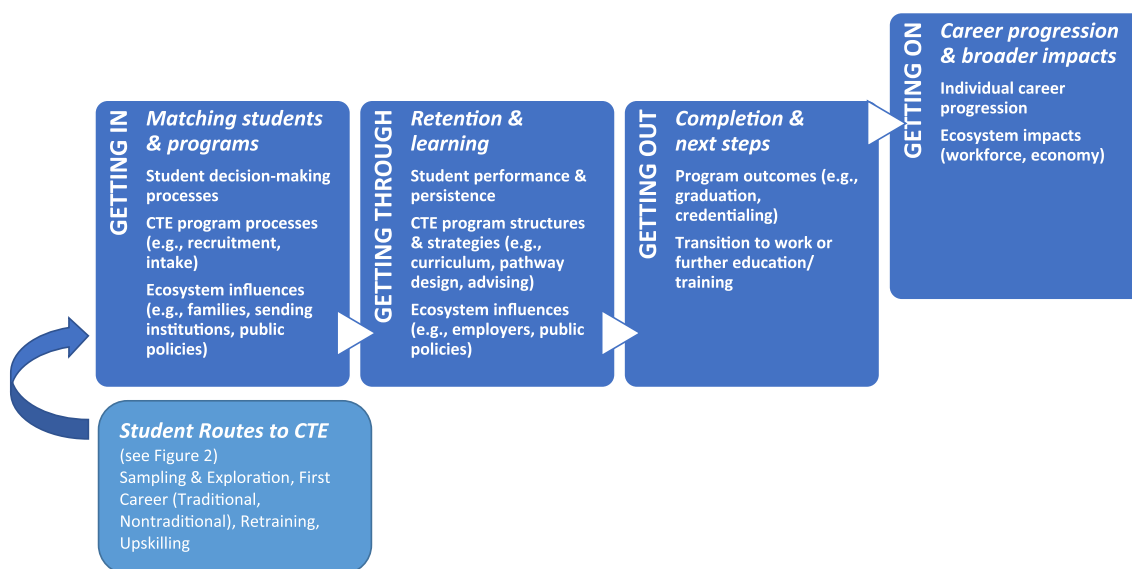


Figure 1 Getting on with CTE: A pathway-based research framework for career and technical education.

It is important to note that in practice the path may not be linear for all student/workers; some may enter and exit CTE and paid employment. In fact, CTE is often a focal point of the career pathways and stackable credentials movements (Bailey, 2017; Bragg et al., 2017; Fein, 2014), where the goal is for students to have multiple on- and off-ramps in education as their careers progress and they require upskilling to advance. These categories are also not necessarily mutually exclusive; students can be in paid employment while also doing classroom CTE, for example, and the line between a paid apprenticeship and employment is muddy. We have placed factors into the parts of the pathway where their fit is strongest.

The model offers a snapshot of the path through a typical CTE program as designed and is applicable to a broad variety of programs and student circumstances. Every study will not cover the entirety of the framework, nor should it be expected to. Rather, much as the life course perspective itself reminds us to consider a broader range of factors when investigating social phenomena, the CTE research framework serves as an orienting perspective that highlights key moments in CTE education, reminding researchers to consider a broad range of factors at each moment and how these moments can be cumulative and interrelated. We will discuss each category in turn.

Student Routes to CTE

One way we address both student agency and timing factors that can influence the CTE experience is to identify students' primary overall goals that lead them to enter CTE programs. These goals represent student agency and can vary based on life experiences, thereby illuminating the various routes that students take toward CTE (the precursor routes). These routes also speak to the timing or sequencing of education in the student's life, and they affect how students go through CTE. They therefore merit consideration when researchers describe the CTE experience and its outcomes. The routes include *sampling and exploration*, *first career preparation (traditional)*, *first career preparation (nontraditional)*, *retraining*, and *upskilling* (see Figure 2 for a complete description of these routes).

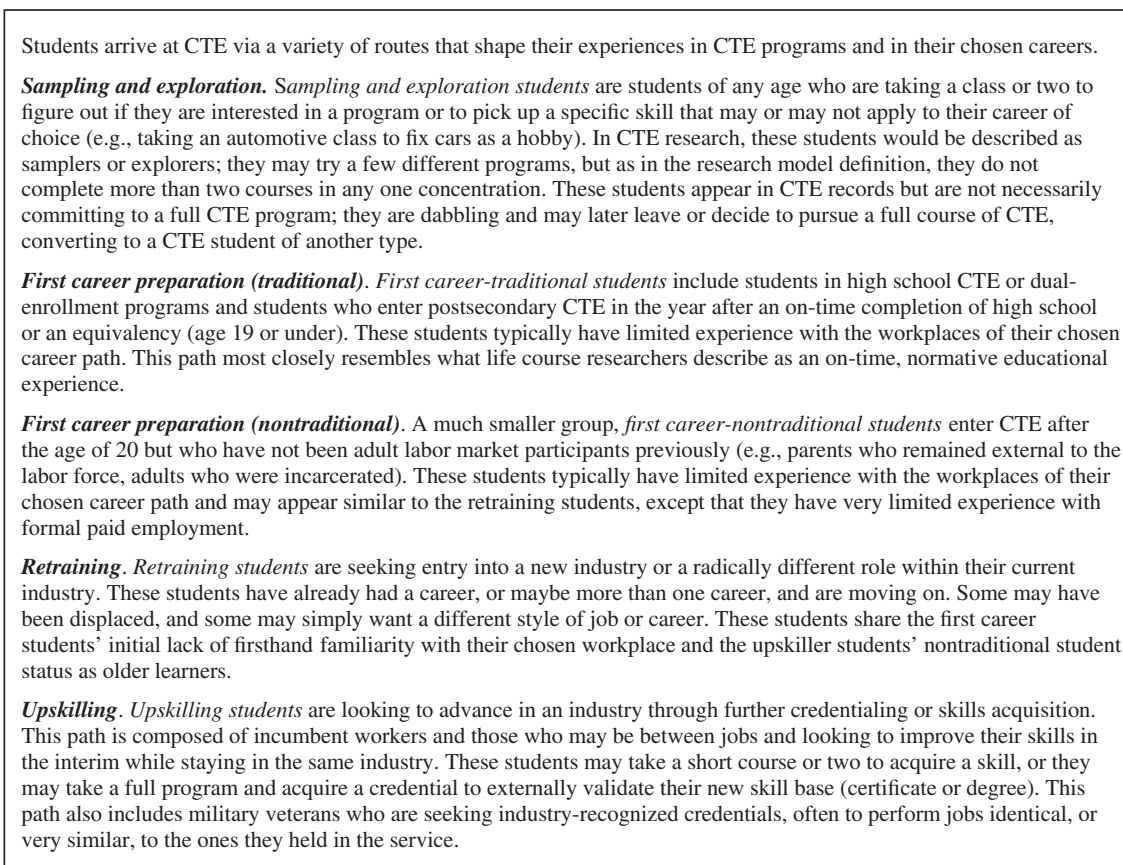


Figure 2 Student routes to CTE.



Figure 3 The getting in portion of the framework.

Getting in (Matching Students and Programs)

The getting in portion of the framework addresses the process of matching CTE candidates to CTE programs (see Figure 3). This is a two-sided matching process. On the student side, there are decision-making mechanisms by which learners successfully enter CTE: how students come to consider CTE, what makes them decide to pursue it, and how they prepare for it. A complementary process to student decision-making is happening on the CTE program side, as programs engage in recruitment and, in some cases, selection to determine the composition of their programs. A broader ecosystem of families and social networks, sending institutions (i.e., the previous school), and public policies are also influential in this process.

Student Decision-Making Processes

CTE proponents argue that optimal CTE training integrates core academic skill development with work-based learning that creates greater commitment and motivation for historically underserved groups (Tucker, 2017). But why do students decide to pursue a CTE path? Student agency in selecting programs is influenced by a variety of factors that merit consideration. Students arrive to the decision-making process with varying individual-level abilities and preferences (e.g., cognitive ability, academic preparation, personality, and career interest), as well as varying social capital and resources (e.g., access to information, financial support) and information frameworks (e.g., how much students know about CTE options and their career prospects) that can affect whether students decide to pursue the CTE path.

Studies have explored some of the ways that individual abilities and preferences influence student pathway selection, but findings can be contradictory. CTE can be an alternative path for students who have not flourished on the traditional academic path. For example, Agodini et al. (2004) used National Education Longitudinal Study (NELS) data to demonstrate that students who have low academic achievement, low educational aspirations, and disabilities or behavioral problems are also disproportionately likely to participate in CTE. Also using NELS data, Cheng and Hitt (2018) demonstrated that student motivations in mathematics and English affect pursuit of CTE offerings, as CTE students were less motivated in mathematics and English and demonstrated lower levels of self-efficacy and effort in these fields. However, this situation is not universal to CTE programs. In fact, in a study of a large southern high school district, Cox et al. (2015) found that students from higher socioeconomic backgrounds and with higher scores on standardized assessments were more likely to participate in career academies, which are broader applications of the CTE concept in as much as they include career training within a more explicitly college preparatory curriculum. This finding was reinforced by Aliaga et al. (2012), who argued for an expanded typology of students that goes beyond academic versus vocational

status. Further research is warranted that examines student backgrounds and achievements as they relate not only to CTE programs themselves, but which CTE programs specifically are selected.

The information framework of students' decision-making is also a critical element of the process, which begs many questions. How much do students really know about their chosen career paths and about alternatives? How much do they know about the CTE programs and processes themselves, and alternatives? Is their information accurate? How do they assess and value this information as they decide? Students' expectations for the programs and how they fit into overall career plans are likely to influence both the decision to follow these pathways, and the experiences they have along the pathways. There is some evidence that students' career plans do not necessarily align with their chosen programs (DeFeo, 2015). Understanding what students are expecting to get from CTE, what advantages they see to the CTE path as compared to a traditional academic path, and whether they consider CTE part of a longer educational path that includes degrees would help us to understand a critical element of decision-making and persistence.

CTE Program Processes

CTE programs engage in recruitment and selection processes that also influence the matching process. A major consideration, therefore, is what successful recruitment looks like for CTE. How can programs educate students about their opportunities and successfully attract students who will benefit from the programs? For programs with competitive or limited enrollment, what selection strategies do programs pursue, and how are these strategies tied to student success? How can programs expose students to the possibilities of CTE? Given its role in matching students so directly to work, student exposure to CTE workplaces may influence their likelihood to participate in CTE programs. For instance, Stone and Aliaga (2005) found that job shadowing can lead to greater CTE participation, more so than apprenticeship and on-the-job training can. These findings speak to the need to study the ways in which students are exposed to different workplaces and career offerings.

Even in postsecondary settings, many CTE programs are open-enrollment, meaning anyone who applies will be admitted. However, the intake processes and requirements for programs can influence student pathways through the programs, particularly in community colleges where some students may be assigned to developmental courses or must first work through prerequisites before they are able to enter their actual programs of study (Bailey, 2009). The ways that programs assess core competencies in their admitted students, and which competencies are most related to program success, are key factors that merits future research. Additionally, some programs grant credit for prior learning, but the evidence base for assessment varies (Stenlund, 2010). It is important to learn which methods of assessing prior learning are most reliable and valid, and how prior learning opportunities affect students' decisions to pursue CTE.

Finally, in the space between secondary and postsecondary education, dual enrollment students pursue CTE through community colleges while simultaneously attending high school. While there is some evidence that dual enrollment is beneficial for future college enrollment and total college credits earned (Kim & Bragg, 2008), what happens next for these learners? Do they matriculate into further postsecondary CTE upon completion? Are they successful in their careers and in further education? Current studies demonstrate great promise. CTE dual enrollment comprises about 30% of overall dual enrollment, and like their counterparts in academic dual enrollment programs, CTE dual enrollment students experience a positive effect on high school graduation, postsecondary matriculation, and college completion (An & Taylor, 2019). Studies also show that the benefits of CTE dual enrollment increase throughout college, potentially even increasing over time (An & Taylor, 2019; Rodríguez et al., 2012). Future issues that merit consideration include the effects of the location of the CTE dual enrollment courses, course modalities, and course types on student success (An & Taylor, 2019).

Ecosystem Influences

Of critical importance, CTE programs and students operate in a broader ecosystem of institutions and social forces (e.g., families and social groups, sending institutions, and public policies) that can influence the initial matching process, often constraining choices available to students.

Families and social groups influence the CTE student in two primary ways. First, family background traits such as demographics and socioeconomic status appear to influence CTE enrollment, but as noted in the previous discussion of the role of student aptitudes, the effects appear to depend at least in part on how one defines a CTE student and which

programs are of interest. Furthermore, community characteristics (e.g., urban, rural, suburban) can also influence CTE participation rates (Stone & Aliaga, 2005). Identifying how these influences may vary by CTE program is an equity issue, as some CTE programs lead to more lucrative career paths; further research is needed to understand whether there are any systemic barriers to participation and success in CTE generally and to more lucrative paths specifically?

Secondly, families and social groups can also play a role in the perception of CTE. Research evidence shows CTE training is mired in misconceptions and stigmatized as a route strictly for failing students or as a second-tier option for students not college bound (Kantrov, 2014). Understanding how parents and peers view CTE and how closely those views hew to the reality of CTE is an important priority for future research. This is also a factor to consider among teachers and administrators, who may support or dissuade students from participating in CTE. Kitchel (2015) found promising results among a sample of principals, who reported that CTE programs were considered important in their schools and that administrators valued how they imparted technical skills into their students. However, more extensive research that examines faculty and staff in high-contact roles with students (e.g., teachers, counselors) could provide insight into the daily messages students are hearing about CTE from their school and community.

Sending institutions vary in this process by student type. High school tracking and student placements, curricula, and advising may influence a students' decision to pursue CTE not only in high school, but also in postsecondary education, particularly for first career and explorer students (see Figure 2). The workforce development system may influence and support retrainers and first career (nontraditional) students through its interest and abilities assessments and case management. Employers may encourage upskillers to pursue CTE through the influence of corporate policies, supervisors, and mentors. Understanding how these institutions support or challenge CTE participation is an important challenge for research. For example, secondary CTE participation may influence postsecondary CTE participation by influencing the quality of information students receive about CTE. In a qualitative study of career counseling offered in CTE programs at three schools, Stipanovic and Stringfield (2013) found that schools offer a variety of formal (career fairs, presentations) and informal methods (informal teacher guidance) for career counseling, but this offering varied broadly. Identifying best practices for schools to implement regarding CTE career counseling may improve overall placements in related postsecondary education. There is some evidence of variability by program in building these pathways from secondary to postsecondary CTE. For example, Plasman et al. (2017) found significant relationships between specific CTE clusters students studied in secondary education and eventually receiving a postsecondary credential in that same cluster. However, this effect may vary by program, as an earlier study by McCharen (2008) found that high school students who completed CTE in the health science technology/health career CTE programs did not necessarily transition into additional postsecondary education in health care programs, but rather entered employment.

Finally, public policy can convey societal support for CTE, or it may discourage the pursuit of CTE. It can also influence how CTE programs are constructed, as federal funding and its stipulations have been major drivers of CTE program design since the Smith-Hughes National Vocational Education Act of 1917 (Friedel, 2011; Jacobs & Worth, 2019). Furthermore, the structure of vocational education varies broadly from country to country, as different nations build educational systems with varying features (Moodie, 2008). Future research should examine how education and workforce policies support or discourage CTE (e.g., Perkins V, individual training accounts through the workforce development system, rules about student financial aid for credit versus noncredit coursework) and examine how those policies relate to admission levels.

Getting Through (Retention and Learning)

After students are matched to CTE programs, the next challenge is keeping them there. Getting through focuses on student performance and persistence, how the CTE programs are structured, and public policies such as wraparound social services that may support CTE learners as they persist in their CTE programs (see Figure 4).

Student Performance and Persistence

Student performance and persistence are critical at this point in the CTE pathway and may be linked to a number of factors. In addition to questions about program performance, key questions to consider include the effects of individual skill difference (e.g., essential cognitive, behavioral, and communication skills), social capital factors (e.g., financial support, education quality, socioeconomic status), and personal characteristics (e.g., age, parenthood, breadwinner status) on CTE learner engagement, training completion, and on-the-job training success.



Figure 4 The getting through portion of the framework.

Understanding CTE preparedness is key if we are to evaluate a range of outcomes, whether tied to college and career readiness standards, or to likely training completion. As mentioned earlier, CTE programs are typically open enrollment. Though student preparedness can affect the intake process for community colleges, due to open enrollment many challenges with student preparedness often manifest in the getting through phase, during which previously acquired knowledge and aptitudes are critical to ongoing retention and progress through the program.

While there is limited direct assessment research targeting CTE learners' aptitudes, there are indirect indicators based on large-scale assessment. For example, we can examine group averages on cognitive ability measures by looking at disaggregated degree attainment groups for both the ACT (a standardized college admissions test measuring English, mathematics, reading, and science) and PIACC (Programme for the International Assessment of Adult Competencies, an international survey of assessment and analysis of adult skills) assessments.

When examining ACT scores, those high school students who are seeking postsecondary vocational, technical, or 2-year college degrees have an average ACT composite score of 16.2 to 16.4 (on a scale from 1–36), respectively (ACT, 2018, p. 28). This is lower than the national average for those seeking a bachelor's degree (score of 20.4) and those seeking a graduate degree after their BA/BS (score of 24.1). Given a 2.5 scale difference is equivalent of a .5 effect size, there are quite large mean differences (ACT, 2018, p. 28). However, these results must be interpreted cautiously for two reasons. First, students can change paths; in cutting the scores by the degree paths students chose, the CTE group loses CTE students who eventually take bachelor's or graduate degree paths. Second, student aptitudes in these areas can be influenced by curriculum exposure. Students who take the recommended college preparation core curriculum have an average ACT composite score of 22.1. Those students who take less than the core curriculum (which would subsume a majority of CTE students) demonstrate ACT composite scores averages of 18.9 (ACT, 2018, p. 21). In essence, CTE students may score lower in these domains because they are not exposed to them in equal measure, rather than because they are inherently lower performers. Furthermore, we must put into context the challenge that *all* students have with meeting college readiness benchmarks; only 24% of students can meet ACT college-readiness benchmarks for three of the four key content areas (mathematics, reading, English, science) (ACT, 2018, p. 18). So, while the evidence suggests that a large portion of CTE high school graduates are not ready for college general education, neither are a large portion of 4-year college bound students.

Another way to evaluate the cognitive abilities or skills (i.e., preparedness) of typical CTE and 2-year college graduates is to examine the large-scale assessment data collected by the ETS for the Organization for Economic Co-operation and Development (OECD, 2012, 2013). Two assessments offer insight into adult skills, the PDQ (prose, document, and quantitative) examination and the PIAAC examination (the successor). These examinations have yielded extensive data across multiple years using more work-contextualized measures of numeracy and literacy. Both rely on the same score scale, with proficiency levels ranging from low (1) to high (5). Proficient is within the Level 3 range, which is associated with skill expectations of most O*NET (National Center for O*NET Development, 2008) Zone 3 and above ability ratings, which is composed of jobs that require medium levels of preparation: more than a high school diploma but less than a 4-year

bachelor's degree (OECD, 2012, 2013). For both PDQ and PIAAC tests, high school graduates and individuals with less than 2 years postsecondary education modal scores are in Level 2. Here again it is important to note that this is a rough proxy for CTE students, who may fall within the group (high school graduates with fewer than 2 years of postsecondary education) but do not comprise that whole group. These findings are in line with findings about the percentage of all U.S. PIAAC test takers aged 16–34, many of whom fall below the minimum proficiency levels (three) for literacy (50% of adults aged 16–34), numeracy (64%), and problem solving in a technology-rich environment (56%) (Kirsch et al., 2021; OECD, 2019).

While these tests offer some insights into the aptitudes of the CTE student population, further, more targeted study is required that directly addresses the aptitudes of CTE students in both secondary and postsecondary education, ideally linking these aptitudes to program outcomes such as persistence and completion. These data give us a snapshot of students on a more traditional route to CTE (the sampling & exploration and first career routes). Future work must focus on student performance for special populations, such as adult learners (those on the retraining and upskilling routes) who comprise a large portion of the population of community college students.

CTE Program Structures and Strategies

A variety of program factors likely influence student retention and progression in CTE programs. Of particular concern is how student's educational pathways are designed and supported in terms of providing advising, instruction, and mentorship to students. Additionally, strategies for engaging students with employers, such as experiential learning (e.g., labs, internships, apprenticeships), can ensure that students' learning is relevant to their chosen field and build connections with local employers.

CTE is a field that offers a high level of applied, and often hands-on, instruction. However, it is also a field that serves diverse learners, particularly in postsecondary education. Designing programs to maximize benefits for all can be a challenge, and ideal modes likely vary by program. We have some evidence that program location is important to outcomes for dual enrollment learners, who fare better with college instructors offering courses on-site at the local high school (Phelps & Chan, 2016). We also know that blended learning is a promising modality for delivering content to community college learners (Means et al., 2013). Further study is warranted into the best ways to structure these programs, both in location and modalities. For a career-oriented educational pathway, it is also important to study how best to offer hands-on learning. More generally, work-based learning helps students apply and extend knowledge and skills, gain motivation, and develop critical understanding of the work environment (Alfeld et al., 2013). Student laboratories, externships, internships, and apprenticeships are models that are deployed differently throughout a variety of programs; understanding the specific value of each modality on the quality of skills instilled, and the connections with local employers is important.

CTE is also affected by a variety of education reforms designed to structure pathways to further education and paid employment. The *guided pathways model*, a structure within community colleges (Bailey, 2017), and *career pathways model*, a structure between education and employment (Bragg et al., 2017), are two promising efforts to create smoother pathways for learners. Both involve more intrusive models of advising, offering a high-touch approach. While these efforts are relatively new and short-term studies are promising, it remains to be seen in the long-term whether they help CTE students become lifetime learners. Future longitudinal studies would be beneficial to assess the strengths of these pathways and their outcomes with respect to later matriculation.

Another pressing concern is how teachers and trainers influence success both in the classroom (through pedagogy) and on the career pathway (through mentoring and connections). CTE instruction at the secondary and postsecondary levels, as well as mentor and supervisor quality in on-the-job education, likely affect student success. How do teacher and training milieu (training context, practicum experiences, and content taught) combine to affect CTE learner outcomes? And how can instructors and mentors best be supported to improve quality? Studies are sparse but indicate that there are some challenges in the fit between teachers' expectations and experiences. In a study of Ohio teachers, Kerlin (2002) found that high school CTE instructors experienced teacher role and task stress at higher levels than general academic teachers, indicating a mismatch between teachers' expectations for their roles and their experience filling their teaching roles, as well as stress in the daily tasks of teaching. How can that stress be alleviated, and does it affect teacher retention and student outcomes? Rehm (2008) found CTE teachers in Florida emphasized language and cultural differences as challenges within CTE programs, which could lead to some dissonance between the instructional practice of teachers and the knowledge acquisition of CTE students. Teachers perceived that maintaining high standards during the CTE courses and building

community with and among students were challenging. These CTE teachers perceived demonstrations, visual aids, and hands-on projects to be the most useful teaching strategies they employed when working within CTE programs and their students.

Whether and how schools teach essential, noncognitive/nontechnical skills (a.k.a. soft skills, e.g., teamwork, perseverance, communication) is another factor that may influence program success and potentially help programs to overcome equity issues. The National Association of Colleges and Employers (NACE) Job Outlook 2018 survey found that employer ratings of work readiness were uneven, with many skill domains in the unprepared range (NACE, 2017). In fact, across the spectrum of jobs (high school degree to college degree requirements), professionalism and work ethic, oral/written communication, and critical thinking/problem solving were considered essential (at above 99% employers), and only 41% to 55% of interviewed candidates were rated proficient (NACE, 2017). These findings highlight the high variability in work readiness tied to behavior and communication expectations in the workplace of entering workers. Can programs address the soft skill challenge? Are these soft skills best addressed by cocurricular or remedial strategies? What do the best traditional programs do to instill these skills, and what would be the impact of technology-based learning platforms to promote deeper learning of essential skills and disciplinary knowledge acquisition? What are the trainee factors associated with more effective digital learning of literacy skills? What are effective strategies to address work-ready behaviors (e.g., conscientious, customer-focused, team player, emotionally stable)? Much work must be done to understand how schools can support students in acquiring these critical skills, which employers expect and demand in the new economy (Golubovich et al., 2017). Evidence-based practices that inform how to measure, benchmark, and improve essential communication, literacy, and behavioral competencies are likely to be critical factors in improving educational equity, student retention, and program effectiveness.

Ecosystem Factors

Recent federal policies and funding streams have prioritized employer engagement in CTE programs (e.g., Perkins V, WIOA, TAACCCT). The intent is for CTE programs to align their training to the needs of local employers, thus ensuring that graduates have market-valued skills and employers have access to a work-ready workforce. According to a recent report by the Urban Institute (Spaulding & Martin-Caughey, 2015), employers can engage with programs in a number of ways: They can provide program oversight or help with program design, assist with program delivery (e.g., through mock interviews, guest speaking, mentorship for students), recruit and hire program graduates, and provide financial or in-kind resources for programs. Employers can become partners through deeper engagement in certain program activities or a broader range of activities and through workforce sector partnerships.

Jobs for the Future has identified five levels of employer engagement, which vary in depth and intensity from new relationships to working relationships, to strategic partnerships (Wilson, 2015). At the new relationship phase is Level I, advising. Working relationships are built in Level II, capacity-building, and Level III, co-designing. Level IV, convening, and Level V, leading, are hallmarks of strategic partnerships. How do students experience these engagements, and which engagements most impact student retention? While these models are instructive, future research is needed on how effective each level of engagement is in building CTE programs that maintain students' interest and enthusiasm and provide them confidence in the quality of their skills.

In addition to policies supporting employer engagement, public policies related to social services are integral to the wraparound services of more proactive or intrusive advising models that schools are beginning to adopt (Fowler & Boylan, 2010). Understanding how these supports may influence CTE dropout rates is an important area for future research.

Getting out (Completion and Next Steps)

Completion is an important criterion of success in any educational program. As CTE is so directly tied to labor market preparation, we consider students taking the next step to also be inherently tied to program success, whether it is initial job placement in the target field or continuing education along the pathway (e.g., high school CTE completion followed by further postsecondary CTE, or a CTE certificate followed by an associate of applied science [AAS] program). Both short-term and long-term outcomes can be taken into consideration when evaluating the efficacy of CTE programs. Our getting out research agenda is focused on short-term program outcomes: whether students finish their CTE program, what

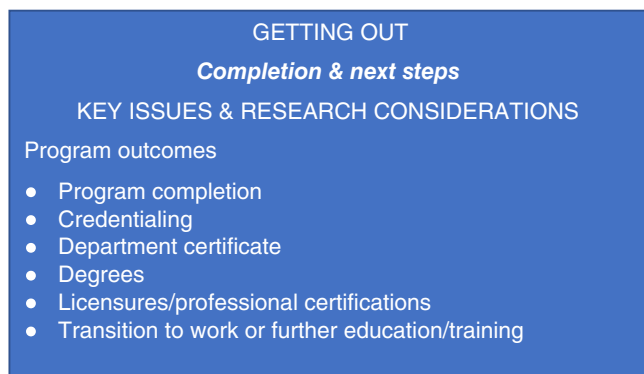


Figure 5 The getting out portion of the framework.

credential they receive and how transferable/industry-recognized that credential is, and whether students immediately obtain paid employment and/or further training along their intended pathways (see Figure 5).

Crossing the Finish Line: CTE Program Outcomes

Do high school students participating in CTE programs graduate, and do these graduates demonstrate academic proficiency levels required for further postsecondary training and for succeeding in skilled technical jobs? Early findings on this are promising. The ACTE highlights several important positive facts about students and adults participating in CTE programs. Within a high school context, graduation rates for CTE students are 93% compared to the national average of 80% (U.S. Department of Education Office of Planning, Evaluation, and Policy Development, Policy and Program Studies Service, 2014; Dougherty, 2018; Gottfried & Plasman, 2018), and 91% of high school students with two to three CTE credits enroll in college (Hudson & Boivin, 2016).

However, program impact may vary by state, as some conflicting findings highlight. To study the education and work outcomes of students in secondary and postsecondary CTE programs in Florida, Jacobson and Mokher (2014) utilized education and employment records to follow a cohort of ninth-grade students for 10 years, finding that high school CTE had little effect on education outcomes such as graduation and continuing to college when controlling for background and family variables; they did find some significant differences between urban and rural students in CTE concentration and continuation to college, though the college outcome was attributable to differences in high school performance and family income. In two quasi-experimental studies using statewide linked data sets, Dougherty et al. (2018) investigated the impact of regional vocational and technical schools in Massachusetts, which were argued to demonstrate higher quality in terms of comprehensiveness of curriculum and instruction. Controlling for selection bias for high school attendees of CTE programs, he found that attending a regional vocational and technical school increased likelihood of graduation by 32% (though it did not affect standardized math and reading scores).

One study in Philadelphia (Neild et al., 2015) found that students who attended CTE high schools had a higher credit accumulation, and a higher likelihood of graduating on time or within 6 years, and that there were some positive effects on college preparatory course-taking. This echoed findings by Cellini (2006) that high school National Longitudinal Survey of Youth (NLSY) students who participated in tech-prep programs had a higher likelihood of completing high school and enrolling in 2-year colleges (though Cellini also found that these students had a lower likelihood of enrolling in 4-year programs). Stone and Aliaga (2005) had less promising findings regarding course-taking, with CTE students taking significantly fewer math and science courses and having lower grade point averages (GPAs) than general academic concentrators. However, CTE concentrators did have a higher high school completion rate.

These findings offer some insight into the impact secondary CTE can have on postsecondary outcomes. However, there is less information available regarding postsecondary CTE learners, and it is important to know whether these students graduate their training programs and whether they are able to pass job-specific certification and licensure exams. This information is critical given the broad variation in noncredit postsecondary education, which houses many CTE programs but is generally subject to only minor regulatory oversight, if any—making CTE the wild west of education (Van Noy

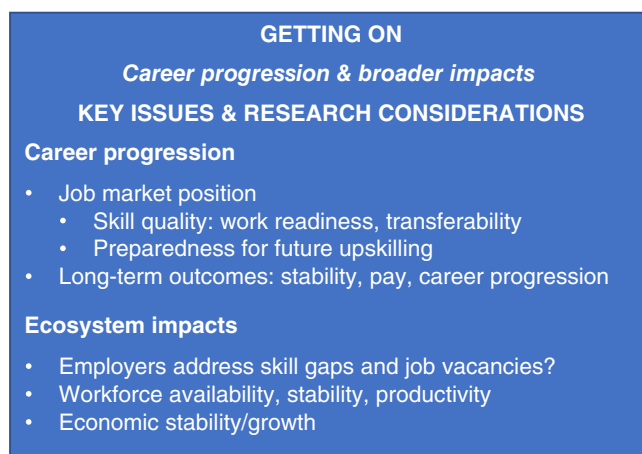


Figure 6 The getting on portion of the framework.

et al., 2019, p. 1). Future research is needed into the quality of the credentials that these programs offer and whether that translates into workplace success.

Getting on (Career Progression and Broader Impacts)

At the end of the day, the ultimate goal of CTE is to create greater opportunities for workers and a more skilled workforce for employers. It is important to ensure that students and employers agree regarding the skills necessary to perform well in the job market and how prepared students are to demonstrate those skills.

For students to be successful, a CTE path must have a positive career trajectory, where students gain significant advantages in their job market position, are work-ready, and are able to succeed beyond their first job (transferable skills and preparation for future upskilling). This includes the long range outlook for students who complete CTE versus comparable non-CTE students (i.e., how their employment outcomes compare to high school diploma holders, how their employment outcomes compare to bachelor's degree holders), whether CTE students go on to achieve further education and training (more CTE, bachelor's degree and beyond), what factors facilitate that (noncredit-to-credit options, stackable credentials, etc.), and how nondegree CTE certifications affect education and employment outcomes (see Figure 6).

CTE Effects on Educational Pursuits and Work Outcomes

To date, several studies have demonstrated that rather than disadvantaging students, CTE has neutral or positive effects on student success, as we outline below. Major areas of consideration include test scores, graduation rates, and education and work outcomes. In some areas, the effect of secondary CTE differs from that of postsecondary CTE. Some of the differences in findings may be related to the different contexts in which studies occur, as states differ in their CTE and other educational policies, as well as their economies and key industries.

Once again, state differences may affect CTE outcomes. In addition to their aforementioned findings regarding Floridian students, Jacobson and Mokher (2014) found high school CTE concentration had little effect on education and career outcomes but also found significantly higher earnings for postsecondary CTE concentrators, particularly for those working in the industry for which they trained. Dougherty and Zeehandelaar (2017) further tested high school CTE impact using a linked data set from Arkansas, finding that students with greater exposure to CTE were more likely to graduate from high school, enroll in a 2-year college, be employed, and earn higher wages. Furthermore, CTE was not a path away from college; students taking more CTE classes were just as likely as their peers to pursue a 4-year degree. However, Flexer et al. (2011) had contradictory findings using a longitudinal, quasi-experimental design with data from the National Longitudinal Transition Study; high school students in their sample who graduated from CTE and work study programs had a higher likelihood of full-time employment.

Improving workforce outcomes for students over the long term is a major goal of the current CTE effort, and one that merits great consideration. As noted, many studies find neutral or positive effects for CTE education; this may be

partly rooted in local policies and economics. Kreisman and Stange (2017) used NLSY 1997 transcript and earnings data to investigate ability differences between CTE and non-CTE students (no meaningful differences found) and found that CTE students taking upper level vocational courses had a 2% increase in earnings for each additional year in CTE. These findings reinforced Dougherty and Zeehandelaar's (2017) Arkansas state findings that those students who took a concentration of at least three or more job specific vocational courses had improved earnings outcomes (especially for men and lower socioeconomic status students). Stevens et al. (2018) estimated income returns to CTE programs from California, the nation's largest system of public higher education with 114 community colleges. The researchers found a positive return with an average 14 to 45% on CTE certificate and degrees.

The effects may vary by personal characteristics as well. Beyond investigating earnings for general education CTE students, Lee et al. (2016) utilized the National Longitudinal Transition Study-2 (NLTS2) to determine potential effects of CTE programs on the postsecondary work outcomes of individuals with high-incidence disabilities. Based on the propensity score analysis, Lee et al. detected significant effects on postsecondary work outcomes for CTE high school students with at least three credits in a single CTE career pathway. The CTE concentrators with high incidence disabilities had a higher likelihood of receiving full-time employment after graduation as opposed to having part-time employment or unemployed after graduation when compared to nonconcentrators with high-incidence disabilities. A study of learning-disabled high school students who were CTE concentrators (Wagner et al., 2017) found that these students were more likely to be employed full time after high school completion than were comparable non-CTE concentrators, but this effect diminished over time.

Other critical questions include whether, from a long-term perspective, CTE students are able to progress along a reasonable career path and meet livable wage expectations. Other long-term outcomes are job mobility and the capacity for retraining as occupations and task expectations shift due to the rapid changes in technology (e.g., automation) and global competition.

Finally, we note that understanding how CTE supports regional economic growth, closes skill gaps, and supports employers is critical to ensuring the ongoing support for these programs. Broader economic analyses and research with employers can support our understanding of the impact not only on learners, but also on the economic health of regions and the employers these regions serve. CTE can also support other policy objectives, as it supplies a large portion of the middle-skill workforce. For example, approximately 54% of nurses received their first nursing license with a vocational or practical certificate, a diploma, or an associate's degree (Smiley et al., 2018, p. S15) indicating CTE through secondary or subbaccalaureate postsecondary education was the first exposure to nursing for more than half of today's nurses. These programs influence how the majority of nurses approach care and offer a talent pipeline that fills our healthcare system. In many cases, these nurses move on to higher levels of education; only about 36% of nurses report a diploma or an associate's degree as their highest nursing degree (Smiley et al., 2018, p. S17). This means that CTE programs were likely formative experiences for nurses at all levels of licensure. These programs are a good place to make interventions to improve quality of care or expand healthcare system capacity. The importance of understanding the impact of CTE on longer term outcomes cannot be overstated for two reasons. First, we do not know how learning that is more focused or how circumscribed sets of job-specific or technical skills contribute to development of critical thinking and problem solving, which promote adaptability in a rapidly changing workplace. Career adaptability, as workplace task expectations evolve with ongoing advances in technology and increased efficiencies, is becoming a critical skill for skilled technical workers (National Academies of Sciences, Engineering and Medicine, 2017). Related, we simply do not know the predictors of longer term career mobility and trainability beyond the expectation that successful workers demonstrate a solid foundation of academic skills (OECD, 2012, 2013). In recent European data (Hanushek et al., 2017), earlier high employment rates decrease as workers age into their 40s and 50s. Ensuring that CTE helps students not only to get in, though, and out of programs, but also to get on with productive careers in good jobs is a critical factor in true CTE success.

Discussion and Conclusion

The study of CTE has not, in recent years, received the levels of attention and resources that have been provided for the study of traditional K-12 and higher education programs. To summarize, there is not much direct evidence on how learners choose CTE programs and whether these learners differ with regard to academic preparation and social capital (e.g., career guidance and informed decision-making). We also do not know the differential impact on postsecondary training, earnings and wages, and career mobility for those high school students who select a CTE curriculum (either as a

cluster of electives or as a full-time concentration) versus those who complete a college-preparatory curriculum. Further, whatever the baseline achievement levels of CTE students, we do not know the degree to which these students meet traditional college or career readiness benchmarks or how they perform in comparison to college preparatory student graduates of similar preparation and aptitudes. A similar lack of clear research is found on understanding how and why adult learners seek postsecondary CTE training and its impact on career and life satisfaction outcomes.

It is critical to note that CTE is not a monolith. Rather, it encompasses a broad variety of programs that can occur in both secondary and postsecondary environments, delivered via different modalities, and targeted to students through late adolescence to adult years. Even within the same industry, CTE programs are generally less standardized than traditional programs. This has led to a variety of research findings that are often contradictory, in part due to variations in definitions of CTE (i.e., who counts as a student?) or lack of studies encompassing wider geographical regions and that can therefore control for regional variations. Creating a stronger shared language for CTE research and a clearer framework that encompass variety can increase the influence of research on CTE design and policy. It is critical, we believe, to improve the evidence base for such a sizeable a public investment in the future workforce.

The model we propose is a normative pathway through CTE and is an inclusive model that represents a complex system; it includes precursor factors and long-term outcomes and therefore offers a holistic view of the forces acting on CTE learners and programs and insight into how the steps along the pathway lead to CTE outcomes. Building from an understanding that multilevel factors influence the pathways and reviewing the existing research, we have highlighted key areas of focus for near-term research.

Getting in

A central concern is the decision-making processes that lead students to consider, and take or reject a CTE pathway. We know that student and family background may play a role, but the nature of that role and how it varies by CTE program requires further exploration. Are certain groups discouraged from taking CTE pathways? What are their information frameworks, and how accurate is the information they receive?

Programs themselves play a role in the matchmaking process. What do their recruitment and intake processes look like, what strategies are most successful for recruitment, and what influence do those factors have on students' likelihood to enter CTE and to persist?

Finally, we must consider the broader ecosystem and how it influences students' decisions. How do families and sending institutions influence the decision-making process? How does high school CTE participation influence decisions about postsecondary education, and does this effect vary by program? How do education and workforce policies encourage or discourage the selection of the CTE pathway?

Getting Through

Student performance and persistence is a great concern and may be related to several factors. Key topics to consider include CTE student preparedness and aptitudes. This issue is perhaps one of the greatest challenges, as most traditional large-scale assessments do not focus directly on CTE and may over- or undercount CTE students in ways that lead to erroneous conclusions about their abilities and talents. Future assessment of CTE students specifically in the domains of essential skills, including academic and soft skills, would greatly benefit the field as programs make decisions about which trainings to offer.

It is also important to improve our understanding of how CTE program structures and strategies influence student performance and retention. What modalities and pedagogies are most effective, and how do these vary by field? Can schools successfully engage in soft skill development? Do reforms such as guided pathways and career pathways help students to persist, and in the long-term to become life-long learners? Longitudinal studies would be useful to illuminate these effects. We also need to learn more about the experiences of CTE teachers, both at the secondary and postsecondary levels.

As policies and programs such as Perkins V, WIOA, and TAACCCT encourage employer engagement, we must ask the following questions: What does successful employer engagement really look like? What strategies are most useful for student persistence and acquisition of quality, industry-recognized skills? And finally, as schools engage in more holistic advising models, how do social services and supports translate to improvements in retention and achievement?

Getting out

Findings are mixed about the role of CTE in student graduation outcomes. This is likely due to variation in how students and programs are defined and also to the specific policies in effect when and where data were collected. It is important, we contend, to build an evidence base that uses consistent terms, such as the research definitions of CTE students (i.e., noninvestors, samplers, investors, and concentrators) and that allows data to be analyzed by state, which gives insight into the effects of different policies on student success.

Furthermore, given the broad variation in postsecondary noncredit programs, future research on the quality of these programs and the credentials they confer is critical.

Getting on

Studies on the long-term effects of CTE on work success and future education are relatively rare. Once again, conducting national, longitudinal studies that focus specifically on CTE students would advance our understanding of how CTE affects students' life trajectories.

Additional studies are also needed of the broader societal effects of CTE. Does CTE help employers close their skill gaps, while giving workers transferable skills? Can it improve regional economies? Empirical studies can help determine these broader effects. The ability to quantify benefits is critical as educational reformers seek to expand these programs and would help build the case to leverage broader societal support for these expansions.

The framework for CTE research outlined in this paper provides, we believe, (a) the structure to identify these multilevel issues and (b) a resource to shape our research in this space as we work to fill critical information gaps and build an evidence base to inform policy and best practices. This is an important mission, as CTE pathways could benefit the large population of individuals that are not completing high school, meeting livable wages, acquiring job-skill benchmark goals (e.g., reading comprehension, numeracy, oral and written communication), or engaging in postsecondary training. Together, these groups comprise nearly 50 million individuals who are unable to obtain skilled technical work (Kirsch & Braun, 2016; Nettles, 2017). A solid foundation of research will help to serve this population most effectively.

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Notes

- 1 The definition of good jobs put forth by Carnevale et al. (2018) is jobs that pay, on average, at least \$35,000 annually for workers between the ages of 25 and 44, and at least \$45,000 annually for workers between ages 45 and 64.
- 2 Clusters include agriculture, food & natural resources; architecture & construction; arts, A/V technology & communications; business management & administration; education & training; finance; government & public administration; health science; hospitality & tourism; human services; information technology; law, public safety, corrections, & security; manufacturing; marketing; science, technology, engineering, & mathematics; transportation, distribution & logistics.
- 3 Occupational credits are from courses that train students for specific vocations, rather than more generalized skills such as math or keyboarding (Dalton et al., 2013, p. ix).
- 4 Definitions of occupational areas and CTE clusters can vary by study. In this particular example, Dalton et al. (2013) defined 11 occupational areas to include: (a) agriculture and natural resources; (b) architecture, construction, and science technology; (c) business; (d) communications and design; (e) computer and information science; (f) consumer and culinary services; (g) engineering technologies; (h) health sciences; (i) manufacturing, repair, and transportation; (j) marketing; and (k) public services.
- 5 Though middle class is generally a squishy concept, it is reasonable to define in terms of household income. The Pew Research Center defines middle income as adults with a household income between two thirds and double the national median, adjusted for household size (Kochhar, 2018).

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Appendix A

The National Career Clusters Framework

Career cluster	CTE-related jobs in cluster
Agriculture, food & natural resources	<ul style="list-style-type: none"> • Agribusiness systems • animal systems • environmental service systems • food products & processing systems • natural resources systems • plant systems • power, structural & technical systems
Architecture & construction	<ul style="list-style-type: none"> • Construction • design/pre-construction • maintenance/operations
Arts, A/V technology & communications	<ul style="list-style-type: none"> • A/V technology & film • journalism & broadcasting • performing arts • printing technology • telecommunications • visual arts
Business management & administration	<ul style="list-style-type: none"> • Administrative support • business information management • general management • human resources management • operations management
Education & training	<ul style="list-style-type: none"> • Administration & administrative support • professional support services • teaching/training
Finance	<ul style="list-style-type: none"> • Accounting • banking services • business finance • insurance • securities & investments
Government & public administration	<ul style="list-style-type: none"> • Foreign service • governance • national security • planning • public management & administration • regulation • revenue & taxation
Health sciences	<ul style="list-style-type: none"> • Biotechnology research & development • diagnostic services • health informatics • support services • therapeutic services
Hospitality & tourism	<ul style="list-style-type: none"> • Lodging • recreation, amusements & attractions • restaurants & food/beverage services • travel & tourism
Human services	<ul style="list-style-type: none"> • Consumer services • counseling & mental health services • early childhood development & services • family & community services • personal care services
Information technology	<ul style="list-style-type: none"> • Information support & services • network systems • programming & software development • web & digital communications
Law, public safety, corrections & security	<ul style="list-style-type: none"> • Correction services • emergency & fire management services • law enforcement services • legal services • security & protective services
Manufacturing	<ul style="list-style-type: none"> • Health, safety & environmental assurance • logistics & inventory control • maintenance, installation & repair • manufacturing production process dev. • production • quality assurance
Marketing	<ul style="list-style-type: none"> • Marketing communications • marketing management • marketing research • merchandising • professional sales
Science, technology, engineering & mathematics	<ul style="list-style-type: none"> • Engineering & technology • science & mathematics
Transportation, distribution & logistics	<ul style="list-style-type: none"> • Facility & mobile equipment maintenance • health, safety & environmental management • logistics planning & management services • sales & service • transportation operations • transportation systems/infrastructure planning, management & regulation • warehousing & distribution center operations

Note. See <https://careertech.org/career-clusters> for more information on these clusters.

Appendix B

Literature Search Terms for Initial CTE Research Framework

Framework	Keyword	Search term
High school getting in	Student choice	“Career and technical education” or “vocational education” AND high school AND course selection (education) OR track selection (education) (“Career and technical education” or “vocational education”) AND TX high school AND TX course selection (education) OR TX track selection (education)
High school getting in	Concentration and nonconcentration	“Career and technical education” or “vocational education” AND high school AND concentration nonconcentration (career and technical education or vocational education) AND high school AND concentration nonconcentration
High school getting in	Course concentration	“Career and technical education” or “vocational education” AND high school AND course concentration (career and technical education or vocational education) AND high school AND course concentration
High school getting through	Teacher support	“Career and technical education” or “vocational education” AND high school AND teacher support TX (career and technical education or vocational education) AND TX high school AND TX teacher support
High school getting through	On the job training	“Career and technical education” or “vocational education” AND high school AND on-the-job training
High school getting through	Apprenticeship	“Career and technical education” or “vocational education” AND high school AND apprenticeship (career and technical education or vocational education) AND high school AND apprenticeship
High school getting out	Licensure or certification	“Career and technical education” or “vocational education” AND high school AND licensure or certification (career and technical education or vocational education) AND high school AND (licensure OR certification)
High school getting out	Educational attainment	“Career and technical education” or “vocational education” AND high school AND educational attainment OR outcomes (career and technical education or vocational education) AND high school AND (educational attainment or outcomes)
High school getting out	Earnings	“Career and technical education” or “vocational education” AND high school AND earnings (career and technical education or vocational education) AND high school AND earnings
High school getting out	Dropouts or completion	“Career and technical education” or “vocational education” AND high school AND dropout OR completion (career and technical education or vocational education) AND high school AND (dropout or completion)

Appendix C

CTE Literature Snapshot

Reference	Keywords	Research design/data source	CTE student definition	Findings
Agodini et al., 2004	High school, demographics, student behaviors	Descriptive statistics/NELS 1988	Vocational concentrator (earning at least three credits in a single occupational area during high school), vocational explorer (earned at least three credits in vocational courses but not in the same occupational area), or vocational investor (both a vocational concentrator and a vocational explorer)	This study investigates factors that influence participation in vocational education by exploring characteristics of students, their parents, and their schools (i.e., demographics, behaviors, and expectations). The study found that students with low academic achievement, low educational aspirations and from low socioeconomic backgrounds have a higher likelihood of participating in vocational education, as do students with disabilities and more behavior problems. Hispanic students are less prone to participate in vocational education than White students, which contrasts other research, while Black and White students are equally likely to participate in vocational programs
Ainsworth & Roscigno, 2005	High school, CTE concentration	Correlation design, quasi-experimental/NELS 1988	Completed agricultural, blue collar, or low-service educational service coursework	This study is an investigation of class, race, and gender disparities in vocational placement. The study found that being involved in vocational education is associated with an increased likelihood of dropping out of high school and significantly decreases the probability of attending postsecondary education. Finally, participation in vocational education is associated with a reduction in unemployment, which is typically less present in minority students and women
Arum, 1998	High school, educational outcomes, vocational programs, states, investments, postsecondary education outcomes	Correlational design, case study, logistic regressions/High School and Beyond (HSB) and Vocational Education Data System (VEDS)	Public high school students with at least five vocational courses on their transcripts	Findings show that states with higher resources allocated to vocational programs have a higher likelihood of graduating CTE students and the likelihood of dropping out increases in states with low levels of investment in CTE schools. Researchers also found that CTE students' occupational coursework is related to an increased likelihood of graduating high school but a decreased likelihood of entering 2- and 4-year colleges. For instance, students taking 20% trade-technical course work have only a 15.9% probability of attending a 2-year college and 19% likelihood of entering a 4-year college, which is lower than the probabilities for nontrade technical course work, 17.7% and 40%, respectively. Parental education and occupation had no effect on the likelihood of attaining a high school diploma. Residence in the urban and northeast region influenced obtaining a high school diploma

Appendix C Continued

Reference	Keywords	Research design/data source	CTE student definition	Findings
Bozick & Dalton, 2013	High school, GPA, graduation, credit transition, credit accumulation	Longitudinal design, quasi-experimental, fixed effects regressions models, time hazard regression models/Education Longitudinal Study of 2002 (ELS 2002)	Undefined	Based on the findings, students' total occupational credits in the last 2 years of high school is not related to achievement on math assessments. There is no statistical difference in mathematical achievement between economically disadvantaged, affluent students, English language learners, and non-English language learners. Math achievement gains are not associated with attendance at a full-time CTE school generally, but suburban occupational course takers have lower math achievement gains than their rural counterparts. There is a positive association between total number of occupational credits and the likelihood of dropping out of school. There were no statistically significant differences between the number of CTE courses taken between enrolled and dropout students. However, students that drop out, on average, have fewer academic credits than persisters over the same period of time
Castellano et al., 2014	High school, GPA, graduation, transition, credit accumulation	multimethod, longitudinal, quasi-experimental design/6,638 student records from three urban districts, stakeholder interviews, classroom observations, and student surveys	Students who attended federally mandated college and career preparatory programs, also known as programs of study	Results show that earning more CTE credits was positively associated with graduation. In some content areas, CTE students had significantly more science, technology, engineering, and mathematics (STEM) or <i>Advanced Placement</i> [®] (AP [®]) credits than the comparison students. However, participating in CTE programs had little effect on increasing college or dual enrollment credits. CTE students had a higher likelihood of continuing the same or related program of study in college that they began in high school
Cellini, 2006	High school, gender, educational attainment, postsecondary education, graduation	quasi-experimental design, longitudinal, time series, linear probability model with family-fixed effects/NLSY 1997, Rounds 1 – 6	Respondents who participated in tech prep programs starting their junior year of high school	Researchers examined the impact of the CTE curriculum tech-prep on educational attainment using family fixed effects. High school students who participated in tech-prep programs had a higher likelihood of high school completion and enrolling in 2-year colleges. However, students participating in tech-prep programs also had lower likelihood of enrolling in 4-year colleges

Appendix C Continued

Reference	Keywords	Research design/data source	CTE student definition	Findings
Cheng & Hitt, 2018	High school; noncognitive skills; student attitudes, abilities, and characteristics; CTE courses; vocational-technical (vo-tech) high schools; educational attainment; employment and income	Quasi-experimental, longitudinal design/ELS 2002	CTE course takers are students of traditional public schools that take five or more CTE courses. Vo-tech school students attend vo-tech high schools full-time	The study examined the relationship of students' noncognitive skills with pursuit of CTE course offerings. Findings reveal that after controlling for background characteristics, students who self-reported lower levels of intrinsic motivation for math and English take a greater number of CTE courses over time. Additionally, in comparison to the noncognitive skills of academic track counterparts, CTE track students also report lower levels of self-efficacy and effort. When students at vo-tech high schools were compared with students at nonvoc-tech high schools, findings show that students who attend vo-tech schools have lower test scores than students who take few to zero CTE courses. Yet compared to these traditional high school students, students at vo-tech schools are more likely to be employed full time during their young adulthood and, hence, have higher annual earnings. In this study, researchers explore the individual returns on VET over a lifespan and examine the effects of national VET systems on economic outcomes. According to the findings, there are meaningful differences between school-based VET programs and work-based programs when considering the literacy and employment effects. VET graduates in countries with school-based VET are less likely than VET graduates from countries with work-based VET to be employed after graduation, but those differences wane over time. Also, individuals that complete VET programs were initially more likely to be employed when compared to general education students. However, the gap between VET and general education graduates lessens over the years
Choi et al., 2019	Labor market outcomes, educational attainment, postsecondary, graduation, retention, cross-national comparison	Propensity score analysis model (PSM)/PIAAC survey	Students in vocational education and training (VET) programs, which are considered vocational or diversified secondary schools	Gender has the strongest influence on earnings for all three CTE career clusters examined, with women earning less than their male counterparts in Iowa. Furthermore, women who complete degrees in business and marketing earn less even than men who enroll in these programs without completing degrees. However, women experience higher salary increases upon completion of an IT associate's degree than their male counterparts. Completion of associate's degrees had a positive influence on earnings for marketing and IT graduates but did not have a significant impact on earnings for graduates of the business cluster
Compton et al., 2010	High school, career clusters, earnings, gender	Quasi-experimental, case study/ Iowa Department of Education, Iowa Workforce Development, and the National Student Clearinghouse (NSC); Consumer Price Index for Midwest Urban consumers	Students participating in any of the CTE career clusters. Specifically, in this study the researchers examined the business, IT, and marketing career cluster	

Appendix C Continued

Reference	Keywords	Research design/data source	CTE student definition	Findings
Cox et al., 2015	High school, gender, race/ethnicity, career academies, enrollment, academic performance	Case study, correlation design, binary regression models/ Cross Pointe School Online, career academy progress monitoring report	Studied students listed as currently enrolled in one of 10 career academy schools with the larger school district	Findings show that White students are more likely to participate in CTE career academies than non-White students overall, and females are more likely to participate than males. The performance of White and Black CTE students is not statistically significant. Finally, students from higher social economic status backgrounds as well as students with higher standardized assessments were more likely to participate or enroll in CTE career academies
Dougherty, 2018	High school, persistence, labor market outcomes	Correlation design, quasi-experimental/administrative data from Massachusetts (Student Information Management System)	Students participated in specialized programs that were a part of large college-preparatory high schools or attended a regional vocational or technical high school	This study examined the causal impact of participating in CTE high schools on high school persistence, completion, and earning professional certificates. According to the findings, participating in high-quality CTE programs increases the likelihood of on-time graduation by 3 – 5% for students who come from a higher income and 7% for students who come from a lower income student
Dougherty et al., 2018	High school, disabilities, postsecondary employment outcomes, CTE concentrators	Longitudinal; correlational design/administrative data from Massachusetts (Student Information Management System)	Students who participated in specialized programs that were a part of large college-preparatory high schools or attended a regional vocational or technical high school	This study explores the effect of participating in CTE on the academic outcomes of students with disabilities. Students with disabilities perform similarly on standardized measures for student achievement when they are compared to CTE students that do not have disabilities. Furthermore, students with disabilities who are in CTE programs have a higher likelihood of graduating high school on time and earning industry-recognized certificates when compared to students who do not have disabilities
Fletcher Jr. & Cox, 2012	Perceptions, high school	Case study; phenomenology/15 interviews and questionnaires, and two focus groups	Undefined	This study explored the meaning Black students connected to their participation in career academies and possible challenges they encountered. Based on the emergent themes, researchers found that career academies led to preparation for the next level but left less time for school-related activities. Students were activity-engaged and not being perfunctory, and there was an unrealized connection with the core academic subject areas
Fletcher Jr. & Zirkle, 2009	Occupational earnings, postsecondary degree attainment	Quasi-experimental; longitudinal design/NLSY 1997	Undefined	The purpose of this study was to determine the relationship between participation in high school curriculum, educational tracks, degree attainment, and occupational earnings. CTE students performed higher than general, dual, and college preparatory track students based on their occupational earnings. However, CTE students were less likely to pursue a postsecondary degree when compared to their counterparts

Appendix C Continued

Reference	Keywords	Research design/data source	CTE student definition	Findings
Flexer et al., 2011	High school, gender, disability, postsecondary education, employment	Case study, quasi-experimental/a three-part survey that included a student record review, student exit review, and 1-year follow-up phone interview	CTE students not clearly or consistently defined	Results show that high school students with disabilities who graduated from CTE and work study programs had a higher likelihood of full-time employment. However, students that completed general academic coursework had a higher likelihood of attending college than CTE students. The effects of other demographic characteristics on both postsecondary enrollment and full-time employment are also explored
Gottfried & Plasman, 2018	High school, course-taking, persistence, dropouts, postsecondary	Longitudinal, correlational design/ELS 2002	Students take CTE courses in any of 21 occupational course categories	This study investigated whether students' grade level in high school predicted differences in the probability of graduating on time or dropping out of high school. Students who completed CTE course-taking at the beginning of high school (i.e., 9th and 10th grade) and later in high school (i.e., 11th and 12th grade) were compared. CTE coursework completion throughout high school was associated with a lower likelihood of dropping out and a higher likelihood of on-time graduation. Completing CTE courses in 9th or 10th grade was not statistically significant in influencing students to drop out of school. Completing CTE courses in 11th or 12th grade was associated with increasing the likelihood of on-time graduation, 1.5% and 1.6% per CTE unit, respectively. However, completing CTE courses in 9th grade was not statistically significant, while completing 10th grade CTE courses was related to only marginal gains in increasing the probability of graduation on-time. There also appears to be minimal association between CTE course-taking prompting postsecondary behaviors (i.e., ever applied, ever attempted, and enrolled within 2 years)
Hanushek et al., 2011	High school, international, outcomes, postsecondary	Correlation design, quasi-experimental/International Adult Literacy Survey (IALS), which includes 15 European countries plus the United States, New Zealand, and Chile	Vocational education students completed progress in business, trade, or vocational courses	This study compares employment rates across different ages for people with general and vocational education. On average, 35% of males in the sample completed a general education and 47% complete a vocational education. Less than one third of students in European countries completed a general degree and instead completed vocational programs at the secondary level. The United States had more students pursuing a postsecondary degree than other countries. Furthermore, individuals completing a vocational education had a high probability of being employed at a young age, though the effect fades with age. Overall, the impact of vocational education varies across countries, as all have different institutional structures for schooling and work-based training

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Reference	Keywords	Research design/data source	CTE student definition	Findings
Holman et al., 2017	High school, preparedness, postsecondary	Descriptive statistics, case study/survey created by researchers	Students enrolled in a CTE-endorsed program	This study explored the relationship between CTE high school students' program on the perception of preparedness for higher education in five program factors (i.e., curriculum, extracurricular activities, facilities, teacher knowledge, and administrator support). Public service students perceived themselves as being more prepared for higher education facilities and teacher knowledge. Business and industry students perceived themselves as more prepared for trade and vocational schools
Kaufman et al., 2000	High school, CTE concentration	Case study, correlational design/teacher and student surveys, high school transcripts, achievement scores for math, reading, and science	Undefined	This examines the impact of curriculum standards, instructional goals, academic/vocational integration, guidance counseling, teacher practices, and work-based learning on student achievement, controlling for student demographics. An increase in the number of times a vocational teacher communicates with a counselor or teacher regarding their program is associated with an increase in academic performance. Also, an increase in the percentage of vocational completers in rigorous science and math courses is associated with an increase in academic performance
Kelly & Price, 2009	High school, CTE concentration	Correlation design, quasi-experimental/NELS 1988	Students were classified based upon the number of courses taken and whether the courses represented a specialization in a specific area. Vocational dabblers were students with fewer than three credits in vocational education, vocational investors had three or more credits in vocational courses, CTE investors earned at least three vocational course credit hours in CTE courses, CTE concentrators concentrated three or more credits in any one of the 21 CTE subfields, and famgen concentrators earned three or more credits in general labor market preparation and/or family and consumer sciences courses	This study investigated whether vocational education in high school provides disengaged students with an educational clean slate that can foster re-engagement. It examined the relationship between vocational course-taking and changes in effort, extracurricular participation, sense of belonging, interest in school, attitudes toward school and teachers, educational expectations, career aspirations, locus of control, and self-concept. The results showed that extracurricular activity, teacher-reported effort, sense of belonging, and attendance all decreased between eighth and 12th grade. Vocational students had lower GPAs, lower scores on NELS-administered assessments, and were less likely to enroll in high-track classes in eighth grade. Vocational investors were 28% less likely to be on the high track when compared to other students. There are also statistically significant differences between the academic background and psychosocial adjustment of vocational investors and nonvocational students. Overall levels of self-concept and locus of control were lower for vocational investors than nonvocational students

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Reference	Keywords	Research design/data source	CTE student definition	Findings
Kitchel, 2015	High school, student leadership development, career readiness, STEM education, perceptions	Cross-sectional descriptive design/census survey created by the researchers of the study	Undefined	This study explored the perceptions of principals regarding CTE programs in relation to student leadership development, career readiness, and STEM education, as well as the extent to which each of the CTE content areas were important to a school's educational goals as defined by their district or local community. Principals reported that CTE programs were considered important to student leadership within their schools and indicated that school administrators valued CTE students gaining technical skills that meet industry standards. Results show that there is a positive relationship between concentrating in CTE during high school and the postsecondary work outcomes of adolescents with high incidence disabilities. Additionally, students with disabilities that were CTE concentrators (three or more CTE courses) in a specific labor area had higher likelihood of full-time employment than part-time employment or unemployment after high school than the non-CTE concentrators with high disabilities
Lee et al., 2016	High school, disabilities, postsecondary employment outcomes, CTE concentrators	PSM/NLTS2	CTE concentrators (students with three or more high school credit in a single pathway) versus nonconcentrators (students with less than a high school credit in a single pathway)	According to the study, CTE student earnings could be predicted by background characteristics: highest credential received, and annual gain in earnings. Although 37% (adjusted 36%) of the variance was explained by the independent variables, the size and direction of the relationship suggests that being male, 25 years of age and older, not receiving a Pell award, having received an associate's degree, and having annual gains in earnings were more important, as indicated by statistical significance of the independent variables
Maguire et al., 2012	Postsecondary education, completers, noncompleters	descriptive statistics, cross-tabulations/(a) Iowa Department of Education Management Information System, (b) Iowa Workforce Development unemployment insurance wage data, and (c) the NSC Postsecondary Student Degree and Enrollment Verification System	Community college students in the manufacturing/STEM career cluster, or the arts/audiovisual/technology/communication career cluster	Results show that high school students that completed health science technology/health careers certification programs did not necessarily transition into additional postsecondary education related to advanced health care programs. Students within the technology/health career certification programs primarily entered employment as opposed to continued secondary education, with most students entering related fields of employment
McCharen, 2008	High school, career pathways, health science	Case study, longitudinal/quasi-experimental/archival enrollment data from Oklahoma Department of Career and Technology Education (2000 – 2001 through 2004 – 2005)	High school students in the health science technology/health career CTE cluster	

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Reference	Keywords	Research design/data source	CTE student definition	Findings
Meer, 2007	High school, earnings, tracking	Quasi-experimental; longitudinal design/NLSY 1988, 1992, and 2000 waves	Students that completed three or more Carnegie units in agricultural, technical, trade, and health-related fields	This study examines whether CTE students would have higher earnings if they participated in other curriculum tracks (i.e., general or business track) and finds that they would not. Based on the gross effects of each track students in general or noncollege preparatory tracks are more likely to benefit from some degree of technical education
Neild et al., 2015	High school, credit accumulation, academic outcome, graduation	Quasi-experimental case study; fixed and random effect modeling/school district of Philadelphia administrative datasets	High school students enrolled in a CTE high school	This study compares high school academic outcomes for CTE lottery applicants who were admitted into CTE schools with those for students who did not receive an acceptance. In Philadelphia, students who attended CTE schools had a higher credit accumulation (by one to two credits) and a higher likelihood of graduating on time or within 5 or 6 years. The impact of CTE schools on college preparatory course-taking in mathematics, science, and foreign language is mixed for chemistry and physics, but positive for both a three-course sequence in mathematics (Algebra 1, Algebra 2, and geometry) and foreign language courses. Regarding academic performance, CTE schools have mixed results for GPA with some cohorts yielding negative effects and other cohorts yielding positive results
Page, 2012	High school, career academies, outcomes, earnings	Experimental design/1,306 students across seven sites	CTE undefined. A career academy student is recognized as a student who attended a career academy at all during a given year	In this study, researchers examined the number of years a high school student was enrolled in a career academy and the average monthly earnings of those students from 4–8 years after graduation. Average monthly earning is derived from the product of hourly wage, hours worked per week, and weeks worked per month. Results show that men that enroll in a career academy for 4 years have a positive return to the career academy, with a \$588 average monthly earning of the treatment assignment on the earnings. There was no significant effect on the treatment assignment and earnings for women who attended a career academy for 3 years. Results also show that students who enrolled in Grades 10 and 11 also experience some increases in their earnings as well

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Reference	Keywords	Research design/data source	CTE student definition	Findings
Plank, 2001	High school, courses, persistence, academic achievement, dual concentrators, academic concentrators	Longitudinal design, quasi-experimental, multiple ordinary least squares regressions and logistic regressions/NELS 1988	CTE concentrators are students who earn at least three credits in a single specific labor market preparation vocational area. Academic concentrator fulfilled four Carnegie units of English and 3 Carnegie units each in mathematics, science, and social studies	This study investigates the relationship between CTE and academic course-taking for high school students and their academic achievement and persistence. A ratio of three CTE credits to every four academic credits had a positive association with student retention. The more CTE credits or courses that a student completed positively impacted the likelihood of the student remaining in school and graduating. Comparing CTE dual versus academic concentrator students, there were only marginal differences on standardized tests of mathematics, science, reading, or history. Thus, students who chose to only participate in general academic courses did not have a high variability in their standardized tests scores from students who were dual CTE concentrators
Plank et al., 2008	High school, course-taking, persistence	Longitudinal; correlational design/NLSY 1997	Undefined	This study examined how the combination of career and technical education (CTE) and core academic courses influence the likelihood of leaving school. There was a significant curvilinear association between the CTE to academic course-taking ratio and the risk of dropping out for students who were at the most 14 years old when they were in 9th grade. There is also an association between the course-taking and likelihood of dropping out for youth that are 15 or more years old when they enter high school. Black and Hispanic students were significantly more likely than White students to drop out. Black and Hispanic students were also less likely to receive diplomas or GEDs
Rabren et al., 2014	High school employment, disability	Case study; correlational design/administrative data from the Alabama Post-School Outcomes Survey	CTE students appear to be captured as students who take at least one semester of career technical education but there may other factors that were not described.	This study examined the likelihood of becoming employed in the year following high school, the having a job upon leaving high school, or becoming employed the year following high school for those who did not have a job upon leaving high school. Students with a specific learning disability (SLD) and/or an intellectual disability who participated in the career tech programs for at least one semester had a higher likelihood of being employed compared to those that did not participate in career tech. Students with intellectual disabilities were less likely to be employed than students with SLD. However, the differences do not remain significant when including participation in career tech.

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Reference	Keywords	Research design/data source	CTE student definition	Findings
Rehm, 2008	Program factors, teacher perception, challenges, rewards	Case study; descriptive statistics, content analysis, and chi-square test/Florida state database constructed survey	Undefined	The aim of this study is to determine the CTE teachers' perceptions of selected rewards, difficulties, and useful teaching strategies in culturally diverse classes in the state of Florida. Based on the results, CTE teachers emphasized language and cultural differences as challenges that teachers find difficult to overcome within CTE programs. Therefore, there may be some dissonance between the instructional practice of teachers and the knowledge acquisition of CTE students. Also, teachers perceived that maintaining high standards during the CTE courses and building community with and among the students were also common challenges they encountered. Finally, researchers found that CTE teachers perceived demonstrations, visual aids, and hands-on projects to be the most useful teaching strategies they employed when working within CTE programs and their students
Stipanovic & Stringfield, 2013	High school, postsecondary, career counseling, CTE pathways, academic advising	Qualitative case study/interviews with various stakeholders (teachers, principals, and state administrators)	Undefined	This study focused on three sets of high school and community college pairs to understand career counseling services offered through CTE programs. Results show that there were formal methods such as career fairs and presentations to inform of career planning options, and there were informal methods where teachers answered career-related questions for students. Career counselors appeared to spend most of their time in academic planning and career development, but this varied across the three schools. In some cases, career counselors supported students in choosing a career pathway that was informed by students' career-based assessments and interest inventory. However, there were some concerns about counselors of CTE programs that may have affected how student advising occurred and how students were placed in CTE programs. Results also show that community colleges had concerns that there was a lack of face-to-face contact with high school students in terms of helping them make decisions related to their majors and future career goals. It also appears that high school staff were not as knowledgeable of career plans and the aspirations of students because there was a lack of individualized interactions. In some cases, community college staff had to support high school students in terms of determining a career pathway and major instead of college counselors at the high school

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Reference	Keywords	Research design/data source	CTE student definition	Findings
Stone, 2002	Career pathways, education outcomes, gender, race/ethnicity, concentrator	Longitudinal design, correlation design (regression analyses)/NLSY 1997, Rounds 1 and 2	CTE concentrator is in a CTE or business and career program. Dual concentrator is a combination academic and CTE program. Academic concentrator is a student in college preparatory, academic, or specialized academic program. General concentrator is in a general program	This study investigated school-to-work (STW) and CTE students, examining the students' characteristics, what characteristics predicted participation in STW or CTE, and attitudinal and behavior patterns of these students. Overall, CTE concentrators appear to be more male and more racially diverse. When looking across multiple years, CTE and dual concentrators increased in the number of female and White students enrolled. Results also show a decrease in the proportion of academic concentrator and dual concentrators, while there was an increase in the proportion of general or CTE concentrators. There are more CTE and dual concentrator students in the geographic West and not as many in the Northeast. However, gender and urbanicity did not influence the likelihood of curriculum concentration. Finally, across all grade levels there is a negative trend regarding student participation in STW activities
Wagner et al., 2016	Credit accumulation, CTE concentrators, employment outcomes, disabilities	Longitudinal; propensity score analysis/NLSY (NLTS2)	CTE concentrators (three or more high school credits in a single career pathway)	Results show that high school students with learning disabilities identified as CTE concentrators (three or more high school credits in a single career pathway) were more likely to be employed full-time after high school completion than non-CTE concentrator high school students with learning disabilities earning fewer CTE credits. However, after 2 years of high school, the effect of taking general CTE courses diminishes and is nonsignificant

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