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Changes in Subbaccalaureate Career and Technical Education Attainment Over Time and Across "Special Populations"

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Abstract

Recent changes to federal career and technical education (CTE) policy have emphasized the importance of closing access and success gaps in postsecondary CTE among "special" student populations including low-income students, racially minoritized students, students with disabilities, and student groups historically underrepresented in nontraditional educational pipelines. Using two nationally representative samples of first-time, subbaccalaureate students, the current study sought to assess the degree to which certificate and associate degree completions in CTE areas of study have changed over time and the degree to which changes over time are moderated by special population membership. Overall, there is some evidence to suggest CTE completions have changed materially over time; however, we find considerable variation across CTE clusters and special populations.

Keywords: postsecondary education, career and technical education, special populations

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The National Center for Education Statistics (2024) defines career and technical education (CTE) as "courses (at the high school level) and programs (at the postsecondary subbaccalaureate level) that focus on the skills and knowledge required for specific jobs or fields of work" (p. 1). This contrasts with academic education which builds "knowledge and skills that represent the accumulated knowledge base in a subject area" (Levesque et al., 2008, p. 75). Generally speaking, CTE instruction involves "more application and less theory than what is taught in academic programs, while academic instruction is typically designed to be theoretical and independent of specific labor market requirements" (Levesque et al., 2008, p. 75). Congress authorized roughly $1.3 billion in fiscal year 2021 to support secondary and subbaccalaureate postsecondary CTE programs in the nation, mainly through Perkins V. Approximately 11 million students participated in these programs in 2019–20 (United States Government Accountability Office, 2022).

While contemporary CTE remains rooted in "vocational education" and is still very much geared toward preparing students for specific occupational fields, material changes to federal policy, in addition to the rise of the College and Career Readiness movement, have slowly etched away the "academic" versus "vocational" educational distinction that was once so prominent in the past (Gonser, 2018). Today, CTE fields of study are organized nationally into 16 CTE career clusters (Advance CTE, 2023) though individual states and districts may structure their CTE offerings differently, perhaps according to local workforce or industry needs (Dortch, 2014). Sample CTE career clusters include Architecture & Construction, Health Sciences, Information Technology, STEM and Transportation, and Distribution & Logistics. These career clusters are linked to corresponding career pathways such that, and as one example, students within the Agriculture, Food & Natural Resources career cluster may receive tailored instruction and training for careers in Plant Systems (Dortch, 2014).

This shift to rigorous and relevant CTE is associated with positive secondary and postsecondary academic and workforce outcomes. At the secondary level, participation in CTE is linked to higher odds of advanced math and science course enrollment, higher math self-efficacy, improved graduation rates, and higher wages early in career (Bozick et al., 2014; Dougherty, 2016; Dougherty et al., 2019; Ecton & Dougherty, 2023). At the postsecondary level, CTE is associated with increased wages and probabilities of employment, particularly in health-related fields (Bahr et al., 2015; Bohn et al., 2016; Stevens et al., 2019). Carruthers and Stanford (2018) found that students enrolled in technical college programs earned more than similar non-students, even when they left without a credential. In her review of the community college CTE literature, Soliz (2023) found that rigorous empirical studies in recent years point to significant labor market returns to technical credentials though the returns vary across location and field of study. However, Soliz (2023) and Ecton and Dougherty (2023) have called for additional research into the long-term economic impacts of postsecondary CTE. This research is highly needed given Hanushek et al. (2017) found initial employment and wage returns to vocational education students diminished over time.

Gaps in the existing literature aside, the overwhelming share of studies indicate the latest brand of CTE supports student academic and workforce outcomes. Unsurprisingly, perhaps, there is a striking degree of bipartisan support for CTE programming among policymakers. Legislation to reauthorize the Carl D. Perkins Career and Technical Education Act of 2006 (Perkins IV) was introduced by congressmembers Glenn Thompson (R-PA) and Raja Khrishnamoorthi (D-IL). The legislation received unanimous passage in the House and was passed by voice vote in the Senate on July 23, 2018. The House agreed to the Senate version of H.R. 2353 two days later, and the bill was signed by President Trump on July 31, 2018, as the Strengthening Career and Technical Education for the 21st Act (P.L. 115—224). The legislation was supported by a diverse and broad coalition of stakeholders including the American Federation of Teachers and the U.S. Chamber of Commerce (Granovsky, 2018).

Growing Concerns for Special Populations in CTE

As support for CTE programming grows, so does an awareness that access to, and support within, CTE pipelines can be stratified and exclusionary and, as a result, the documented benefits of CTE participation and completion—which include increased high school graduation (Gottfried & Plasman, 2018), college enrollment (Dougherty, 2018), and employment (Dougherty et al., 2019)—largely fall to the already privileged (Carruthers et al., 2021). While there is a collective sense that policy changes over time have steered CTE in a positive direction, towards "rigor and relevance," and away from its "dark history" (Gonser, 2018; Oakes, 1985) of tracking disadvantaged students into low-wage, low-opportunity occupations, existing evidence highlights some concerning trends.

For example, Sublett & Gottfried (2017) found that females were significantly less likely than males to pursue STEM-focused CTE in high school. This finding was supported by Carruthers et al. (2021), who found in their multistate analysis that gender disparities in CTE pipelines reflected broader "gender segregation in the labor market" (p. 14). This study also found that secondary CTE pipelines mirrored local educational access inequalities. More recently, Ecton and Dougherty (2023) found strong evidence of gender gaps in CTE enrollment—gaps that also mirrored broader occupational segregation in the nation. Additional research has found that students with disabilities (SWDs) were less likely to pursue CTE and those that did were less likely to gain from them (Gottfried & Sublett, 2018). Research at the postsecondary level has found that English learners (ELs) and students from low-income households are overrepresented in lower-paying CTE fields of study (Reed et al., 2018). A recent study by Sublett & Plasman (2024) found that rural community college students were less likely to pursue

STEM-focused CTE fields of study, especially among rural students who attended rural community colleges.

This accumulating body of research has led to concern among policymakers and CTE advocates who worry that, rather than lifting special student populations out of social and economic disadvantage, inequitable CTE programming may further entrench their disadvantage and, by extension, feed growing social and economic inequality in the nation. This would represent a shortcoming of the Perkins legislation which, from its inception, has prioritized economic opportunity for historically disadvantaged communities (Brewer, 2009). This reality would also run contrary to the Biden Administration's belief that "advancing equity, civil rights, racial justice, and equal opportunity is the responsibility of the whole of government" (Biden, 2021, para. 3). Inequitable access and success in CTE would also foil Education Secretary Cardona's target of "leading the world in advanced career and technical education" (Cardona, 2023, para. 71). Fortunately, while broadening access to high-quality CTE programs has been a policy target for generations, Perkins V markedly expands this priority and, for the first time, contains substantive funding and accountability mechanisms related to special student populations.

Who Are Special Populations?

The term "special student populations" refers to student demographic groups that experience persistent hardship and have been historically excluded from educational opportunities, including CTE. There are nine special student populations in Perkins V: (a) individuals with disabilities; (b) individuals from economically disadvantaged families; (c) individuals preparing for non-traditional fields; (d) single parents; (e) out-of-workforce individuals; (f) English learners; (g) homeless individuals; (h) youth who are in, or have aged out of, the foster care system; and (i) youth with a parent who is a member of the armed forces and is on active duty (Thompson, 2018).

Special populations are discussed throughout nearly 10 different sections within Perkins V (The National Alliance for Partnerships in Equity, 2018); however, there are two very notable additions to the legislation. The first is the special population recruitment state funding set aside, which allows states to use up to $50,000 of their Perkins State Leadership funds to target and recruit special student populations into CTE program areas through marketing activities. The second is the Comprehensive Local Needs Assessment (CLNA) which requires all recipients of state funds to, among other things, analyze disaggregated student performance data by special population group, identify performance disparities, and generate and apply an action plan for helping special populations overcome barriers to access and achievement. The CLNA also requires CTE providers to engage with a body of local stakeholders which, by law, now must include representatives of special populations. Locals must complete the CLNA every two years.

There are other policy mechanisms in Perkins V that signal a growing commitment among policymakers to increasing equity in CTE. These include a new award incentive program that states can grant to locals who make progress in closing access and achievement disparities for special populations. State funding to local providers does not come with explicit funding set aside to serve special populations, yet five of the six required uses of local funds now relate, to some extent, to special populations (The National Alliance for Partnerships in Equity, 2018). Local recipients of state Perkins V funds are also now able to reduce or eliminate out-of-pocket expenses for special populations, including costs associated with fees, transportation, childcare, or mobility challenges. Last, while law requires states to award at least 85% of their allotment to local providers, states have the option of creating a reserve fund of up to 15% to allocate to locals serving high numbers of rural students, or to areas with high disparities or gaps in performance among special populations.

The emphasis on increasing participation and success among special populations is a promising policy development. First, prior research has found students from disadvantaged backgrounds can benefit from CTE participation. For example, Aragon et al. (2013) found that female students gained significant increases in academic motivation from their CTE experiences. Gottfried & Plasman (2018) found that STEM-focused CTE in high school boosted college completion among female engineering students. Theobald and colleagues (2018) found that SWDs who enrolled in a "concentration" of CTE courses had higher rates of employment following graduation. Additionally, work by Plasman et al. (2022) found that STEM-focused CTE increased self-efficacy as well as graduation and college enrollment rates among SWDs. Low-income students enrolled in high school CTE have reported increased academic engagement (Plasman et al., 2021). More recently, Ecton and Dougherty (2023) reported that high school CTE concentration was associated with strong workforce outcomes and that these outcomes were particularly beneficial for historically marginalized student groups, including low-income students, and SWDs.

Second, broadening access and success in CTE is critical not only because it aligns with the mission of public education, which is to open social and economic opportunity for all Americans, but also because CTE is a critical component of the nation's broader workforce development strategy and, therefore, has the potential to drive economic growth and increase the nation's competitiveness abroad. According to Carnevale and colleagues (2018) at the Center on Education and the Workforce, a rise in skilled-services industries in recent years has led to a "robust non-BA [bachelor's degree]" economy (p. 18). While the share of jobs requiring a bachelor's degree has grown sharpest over time, the share of jobs requiring technical skills and some training beyond high school has also grown. The lack of available workers with the skills and training to fill these jobs threatens to constrain economic growth and ingenuity. Broadening access to CTE not only increases equality and opportunity for special populations, but it also has the potential to build the stock of workers equipped with in-demand technical skills and training, help close the "skills mismatch," boost productivity, and improve economic and social wellbeing.

Study Purpose

Despite seeming consensus around the need for more accessible CTE programs of study, fundamental research gaps exist. Most glaringly, and despite federal initiatives and expenditures to support the retention and completion of special populations in CTE programs of study, we know very little about the degree to which postsecondary CTE participation among special student population groups has changed over time. Existing research is helpful, but not entirely complete. For example, Levesque and colleagues (2008) examined CTE completion over time, but their study preceded the passage of Perkins IV. Second, the overwhelming share of existing studies that have examined changes in CTE participation and completion over time are limited to secondary school contexts (Ecton & Dougherty, 2023; Giani, 2019; Levesque et al., 2008; Malkus, 2019). To our knowledge, no prior study has examined CTE participation and completion among special populations across CTE career clusters and over time using a nationally representative sample of postsecondary students. This gap hampers practice, policymaking, and research. For postsecondary practitioners, the lack of research makes it difficult to establish baselines and trends, to assess institutional effectiveness, and to design and target interventions. For policymakers, the lack of research fosters uncertainty as to whether fundamental and costly changes to policy are effective and resource efficient. The lack of understanding also leaves open the question as to whether prevailing career education policy is sufficiently preparing a diverse pipeline of future workers. For researchers, the fundamental lack of understanding of special populations in postsecondary CTE helps preserve collective ignorance and stifle future studies. The proposed study seeks to address these gaps in policy, practice, and research by addressing the following research questions:

1) How has subbaccalaureate award completion across different CTE fields of study changed over time?
2) To what extent are there differential patterns in subbaccalaureate CTE completion among special populations?
3) To what extent are changes in subbaccalaureate CTE completion over time moderated by special population membership?

Theoretical Framework

The decision to attend college—including which college and what field of study to pursue—is one of the biggest decisions young adults will make. Understanding why students choose a certain college or field of study has been a topic of much theoretical and empirical work. From the theoretical perspective, Perna's (2006) integrated model of college choice is one of the most accepted and cited theories. This model identifies four contextual aspects that ultimately influence college decisions.

The base layer identifies the context that is specific to an individual's background and beliefs. As such, this layer identifies how characteristics such as gender, race/ethnicity, and socioeconomic status influence the accumulation of social and cultural capital which have strong influences on the college decision process (Perna, 2000). This extends to college preparedness and achievement, as well as financial resources, which are also key determinants of college choice (Agger et al., 2018). An individual's background and exposure to certain fields of study in conjunction with perceptions toward that field of work are very likely to influence decisions to pursue a given pathway into college (Mintz & Krymkowski, 2014).

The second layer in the model highlights the high school and broader community context. Essentially, this layer explores the roles communities and schools play in presenting supports or barriers in the postsecondary choice process (McDonough, 1997). Within the school context, teachers, counselors, and peers may both help and hamper the college application process, while at the community level, peers, mentors, and role models may serve in a similar capacity (Stanton-Salazar, 1997).

The third layer in Perna's model brings in the higher education context. Postsecondary institutions play a large role in facilitating the college choice process through information on enrollment, whether due to the physical proximity to students or through active recruitment efforts (Chapman, 1981; McDonough, 1997). Further, institutional and program of study characteristics, and their alignment with student identities and support needs, also play a role in students' decisions (Nora, 2004). Admission standards that align with student abilities and the selectivity of a given institution or program of study also influence students' enrollment decisions (Manski & Wise, 1983; Perna, 2005).

The final layer in the model expands to encompass social, economic, and policy contexts. Within the social context, aspects such as local demographic patterns are considered. The economic context accounts for local and regional employment rates and demands in specific occupations. Finally, the policy context refers to public policies, such as the Perkins Act, that may influence funding opportunities—whether at the institutional or individual level—or that may support certain fields of study (Perna & Titus, 2005).

College Choice and Changes in CTE Participation

Perna's (2006) framework is well-suited for understanding how and why participation in certain fields of study may have changed over time and by student characteristics. We know from existing literature that factors in the base layer such as gender, race/ethnicity, and income are associated with postsecondary CTE enrollment and completion (Carruthers et al., 2021; Ecton & Dougherty, 2023; Reed et al., 2018; Sublett & Gottfried, 2017). Existing research also illustrates that community and cultural factors influence college decision making (Agger et al., 2018; Byun et al., 2017; Hillman & Weichman, 2016; Israel et al., 2001). Existing literature certainly illustrates that institutional practices and characteristics relate to postsecondary CTE outcomes. Importantly, these layers within Perna's (2006) framework would not explain, on their own, why CTE uptake and completion might change over time and across student populations. We argue the fourth layer serves as the primary explanatory mechanism for these changes. In particular, we hypothesize changes to federal CTE legislation—and Perkins specifically—as the chief explanatory mechanism of any observed changes in postsecondary CTE completion. As we described previously, the 2006 reauthorization of Perkins placed a heavy emphasis on academic integration, college and career readiness, and recruiting and supporting special populations in CTE pipelines. Perkins V placed an even stronger emphasis on these areas to the extent that local CTE providers are now required, by law, to quantify disparities in access and completion among special student populations and to demonstrate meaningful progress in closing these gaps. Moreover, Perkins legislation now includes funding mechanisms and increased flexibility to help local providers better target and support special student populations. The current study does not empirically test whether these policies have had a causal impact on CTE completions at the postsecondary level. Rather, we lean on the intersection of the factors included within Perna's (2006) model as a conceptual basis for our analysis.

Methodology

Data

Data for the current study came from the two most current iterations of the National Center for Education Statistics' (NCES) Beginning Postsecondary Students (BPS) Longitudinal Studies. The Beginning Postsecondary Students Longitudinal Study of 2004–2009 (BPS:04/09) collected and followed a nationally representative sample of roughly 16,500 National Postsecondary Student Aid Study-eligible first-time college students for six years, starting in 2003–04 and ending in 2008–09. The Beginning Postsecondary Students Longitudinal Study of 2012–2017 (BPS:12/17) used a similar methodology to collect and follow a nationally representative sample of roughly 25,000 students starting in 2011–12 and ending 2016–17. Both BPS studies surveyed participants at three points in time: at the end of their first, third, and sixth academic years. To ensure compliance with federal guidelines, we sought and received NCES approval to analyze the restricted-access versions of both BPS:04/09 and BPS:12/17 student data and in accordance with NCES restricted-access data reporting guidelines, all numbers in this report have been rounded to the nearest 10.

Given Perkins funding at the postsecondary level is directed toward subbaccalaureate institutions, we dropped student observations for those who began their postsecondary study at a 4-year institution. A number of students within this subbaccalaureate subsample were missing essential transcript information detailing whether or where they earned a postsecondary credential. Additionally, there were a number of missing values on key variables of interest in the study. An assessment of missingness across the outcome, predictor, and control measures revealed rates of missingness that ranged between 1%–2%. To maximize statistical power while mitigating potential bias stemming from list-wise deletion, we used multiple imputation to estimate 20 sets of plausible values which were then imputed back to the sample for cases in which NCES provided sample weights were set to non-zero. These weights were used for imputation and during all empirical analyses.[1] After carrying out the aforementioned sample restrictions, successful multiple imputation, and all mergers with external data sources (e.g., IPEDS), the final analytic sample for the current study was composed of roughly 10,080 postsecondary students from over 40 distinct U.S. states and nearly 320 subbaccalaureate institutions.

Outcomes

The outcome measures in the current study were binary indicators of CTE (a) certificate, (b) associate, and (c) award completion. We used the BPS student transcript files to create these measures. Students who had earned a subbaccalaureate certificate or associate degree in a CTE field of study within the BPS study window had values equal to 1 on these measures, respectively. We coded students equal to 1 on the award completion measure if they had earned any type of subbaccalaureate award (e.g., certificate or degree) within a given BPS study window.[2]

We elected to structure CTE award completions using the NCES Postsecondary Taxonomy which organizes Classification of Instructional Programs (CIP) codes into "academic" and "occupational" areas of study. We operationalize CTE in this study as any and all CIP codes falling within the occupational area as defined by NCES. A common framework for organizing subbaccalaureate, postsecondary CTE areas of study is the national CTE Career Clusters framework (Dortch, 2014). This particular framework divides subbaccalaureate CTE fields of study into 16 career clusters. We aggregated individual areas of study (i.e., occupational CIP codes) into larger clusters as there were insufficient numbers of student observations in several areas of study. More specifically, we combined CTE awards in the "Consumer Services," "Communication & Communication Technologies," and "Business & Marketing" areas into one cluster area called "Business & Marketing." We combined CTE awards in the "Computer & Information Sciences" and "Engineering, Architecture, & Science Technologies" areas into one cluster called "Applied STEM." We combined CTE awards in "Education," "Protective Services," and "Public, Legal & Social Services" into one cluster called "Public Service." We combined CTE awards in "Manufacturing, Construction, Repair & Transportation" and "Agriculture & Natural Resources" into one cluster called "Trades." Finally, we kept "Health Sciences" as its own area of study.

1 We follow the recommendations and best practices of the National Center for Education Statistics and use the NCES-supplied panel weights (wtb000) in our analyses given we utilized student observations collected over multiple data collection waves. Additional information on these weights can be found in the publicly available codebook and technical manual.

2 Awards earned at 4-year, baccalaureate-granting institutions were not factored in the development of the outcome measures.

Predictor

The primary predictor in the current study was a binary indicator of BPS cohort membership. Students in the BPS:12/17 cohort were equal to one on this measure; BPS:04/09 were coded zero. After all data mergers and imputations, the final analytic sample contained 5,900 BPS:04/09 students and 4,180 BPS:12/17 students.

Controls

Covariate selection was informed by Perna's (2006) conceptual model of college access and choice. To align with the first layer of college choice, we included sociodemographic factors such as a binary indicator for sex/gender, a categorical measure of race/ethnicity, and TRIO eligibility indicators including whether a student's family had an annual income that was less than or equal to $25,000 and whether the student had parents who had earned a bachelor's degree or higher. We also included a continuous measure of students' age at college entry (measured in years). To align with Perna's (2006) second layer, we included measures related to students' academic behaviors and achievement. These measures included a categorical measure of students' degree program, and an indicator for whether a student completed dual enrollment coursework in high school.

With respect to the higher education contextual layer, we merged in institutional data from IPEDS to control for institutional sector (i.e., public/private, for-profit/non-profit), the unduplicated 12-month headcount, and the percentage of students identifying as underrepresented racial minorities. We also controlled for year-specific measures of the number of degrees an institution awarded in Health Sciences; Business & Marketing; Communication & Information Sciences; Industrial, Manufacturing & Engineering Systems; and Human Services. Last, we included an indicator of whether a subbaccalaureate institution was situated within a rural locale. Both BPS studies include a categorical measure of urbanicity derived from the NCES Education Demographic and Geographic Estimates (EDGE) program, itself based on the U.S. Census Bureau's most recent urban and rural definitions (Ratcliffe et al., 2016). The EDGE framework delineates all U.S. territory into four locale types: City, Suburban, Town, and Rural. These four locale types are then further differentiated by three categories based on size and proximity. City and Suburban assignments can be either Large, Midsize, or Small (e.g., City-Large or Suburban-Midsize); Town and Rural assignments can be Fringe, Distant, or Remote (e.g., Rural-Fringe or Town-Remote). Technical documentation outlining the NCES EDGE program and the NCES locale framework is publicly available for reference (Geverdt, 2017). Locale boundaries and the Topologically Integrated Geographic Encoding and Referencing (TIGER) codes used to generate them are available for reference on the NCES EDGE program site (Institute of Education Sciences, 2020). Institutions within any of the three rural locale assignments (i.e., Fringe, Distant, or Remote) were considered rural while any locales with either the city, suburban, or town designation were considered non-rural.

In alignment with Perna's (2006) fourth layer, we chose to include state fixed effects terms to control for all sources of observed and unobserved heterogeneity across states.

We pursued this analytic strategy because funding decisions, policies, and labor markets vary widely across states and rather than attempt to control for these differences using observed measures, we decided that state-specific dummies would be a more effective strategy. First, the focus of our study was not on identifying individual state-level factors associated with the CTE outcomes. Second, it is not possible to control for everything; some state-level differences are simply not observable in the available data. State fixed effects represent the most efficient and effective approach to mitigating estimation bias because these terms account for both observed and unobserved state-level factors.

Analysis Plan

We fit a series of conditional linear probability models to answer the first research question.[3] More specifically we fit five linear probability models of the following specification:

$$Yijs=\alpha+\delta BPSi+X'ij\theta+\gamma s+\varepsilon ijs \tag{1}$$

where *Y* was a placeholder for one of the five binary CTE career field outcomes for student *i* attending institution *j* within state *s*. On the right side of the model, *BPS* was an indicator of whether a student was in the BPS:12/17 cohort and the associated coefficient, δ, was the primary estimand of interest. The vector $X'ij$ contains the full set of control measures in Table 1; γ represents state fixed effects. We elected to cluster the error term, εijs, at the school level to account for nested observations among students within the same subbaccalaureate institution (Abadie et al., 2017).

To test for any differential impacts or associations among special populations, we amended Model 1 to include interaction terms between BPS and indicators of whether a student was female, low-income, an underrepresented racial minority (URM), and whether a student had a disability. Also, even though students residing in rural areas are not a federally designated special population, rural students face a number of access and success barriers that, collectively, see them underrepresented in postsecondary education (Dobis & Krumel, 2021; Hillman & Weichman, 2016; Marré, 2017; Provasnik et al., 2007). In light of the historical disadvantages experienced by rural students, Perkins V allows states to build and allocate reserve funds to postsecondary institutions serving high numbers of rural students. Consequently, we also test for differential impacts among students attending rural institutions. As an example of our empirical approach, to test for differential associations between *BPS* and CTE completion among female students we fit a linear probability model identical to Model 1 except for the inclusion of a multiplicative term equal to student BPS cohort membership $*$ female:

3 We also fit identical logistic regression models. Estimates were comparable across both analytic approaches, but we elected to report linear probability estimates for ease of interpretation. Estimates from our binary logistic regression models are available by request.

$$Y_{ijs}=\alpha+\delta BPS_i+\beta FEM_i+\varphi(BPS_i*FEM_i)+X'_{ij}\theta+\gamma_s+\varepsilon_{ijs} \quad (2)$$

where the parameter φ represented the change in the BPS slope unique to females in the sample. Practically speaking, φ tests whether the relationship between the BPS cohort indicator and the CTE completion outcomes, represented by Y_{ijs}, is a function of sex/gender.

Limitations

The current study is not without limitations. First, while changes to federal CTE policy motivate the current study, we do not seek to estimate any causal impacts stemming from these changes. We do hypothesize the policy changes to Perkins to broaden access to subbaccalaureate CTE, but we do not empirically test this hypothesis here. Rather, our goal is to address existing research gaps which include a fundamental, non-causal understanding of the degree to which CTE completion among special student populations varies across CTE clusters and has trended over time.

Second, many factors have the potential to influence CTE enrollment and completion over time other than federal- and state-level CTE policies and, consequently, we caution against drawing blanket generalizations. For example, total college enrollment spiked during and after the Great Recession of 2008 (Dundar et al., 2011). During the same period, aggregate federal- and state-level funding decreased and borrowing skyrocketed (Mitchell et al., 2018). The 2009 Trade Adjustment Assistance Community College and Career Training (TAACCCT) Grant Program helped community colleges build hundreds of new industry-aligned programs in fields including manufacturing, health care, information technology, and transportation. Gainful employment regulations stemming from the Obama Administration's broader scrutiny of the for-profit sector changed student enrollment patterns and selection into postsecondary institutions. Last, the composition of the college student population has changed over time and, more specifically, has become more diverse (National Center for Education Statistics, 2020). Each of these underlying trends and developments has the potential to impact the number and composition of students within postsecondary CTE pipelines.

Third, our data do not allow for analyses fully inclusive of all special student population groups. For example, there were less than 100 participants who identified as veterans and just 20 participants who were homeless or at risk of homelessness in the BPS:12/17 subbaccalaureate subsample. Also, while both BPS iterations identified whether English was the primary language spoken at home, this measure did not identify participants as English learners. BPS does not collect information on participants' experiences with foster care. Consequently, the current study was unable to assess the degree to which all groups of special student populations have interacted with CTE differentially across CTE clusters and over time. Fourth, though NCES utilized a similar sampling methodology across the two BPS studies, leading to similarly representative samples with sample weights, we cannot entirely rule out the possibility that identified differences across BPS samples are due to naturally occurring sampling error. Like Theobald et al.

(2018), we mitigate this issue by comparing baseline descriptives across cohorts and by including sample weights in our analyses.

Fifth, and last, our data do not allow us to understand why students choose to pursue a credential in a given CTE field. We are simply able to observe trends over time. Understanding students' motivations, particularly those who come from special populations, to pursue a given CTE credential would go a long way toward filling in the outline we have provided here and shining light on why certain special populations remain underrepresented in different CTE fields. Future work could pursue this avenue of research through a qualitative study examining why students choose (or do not choose) to participate and persist in different CTE fields. Despite these limitations, we feel our work adds to a severely underresearched field of study. Though we seek only to provide descriptive evidence as to how participation in different postsecondary CTE fields of study changed in the decade plus between 2004 and 2017, we hope this work will provide a solid foundation for future explorations on postsecondary CTE participation and credentialling and encourage policymakers to consider how to ensure these lofty goals related to special populations can actually be met.

Results

Descriptive Comparisons

Table 1 shows the percentage of students in the sample who earned certificates or associate degrees in each of the five CTE cluster areas, across BPS cohorts. Figures in the table show that BPS:04/09 participants earned certificates and associate degrees in CTE cluster areas at statistically comparable rates as BPS:12/17 participants, with few exceptions. For example, a slightly higher share of BPS:12/17 participants earned associate degrees in fields within the Business & Marketing and Trades clusters. Overall, however, rates of completion across the two BPS cohorts were largely similar.

Figures in Table 1 also show the degree to which BPS:04/09 participants were compositionally comparable to BPS:12/17 participants. Slight differences are apparent; just 2% of BPS:12/17 participants were not in a degree program, but this was the case for 13% of BPS:04/09 participants, perhaps because a larger share of BPS:12/17 participants were enrolled in public, 2-year colleges. Also, BPS:12/17 participants were enrolled in a bachelor's degree program at a rate that was 4 percentage points higher than BPS:04/09 participants, perhaps reflective of the growth in baccalaureate program offerings among subbaccalaureate institutions. The far right column of Table 1 contains the effect sizes of the average differences for each of the outcome and student-level controls across the two BPS cohorts. With the exception of two measures, each mean difference is less than a fifth of a standard deviation apart. The first exception is age at entry ($g = 0.21$) and the second is the share of students not enrolled in a degree program ($g = 0.37$). However, these differences are small to modest according to widely used interpretations (Cohen, 1988).

Table 1. Student-Level Descriptive Statistics, by BPS Cohort

	BPS:04/09		BPS:12/17		
	Mean	*sd*	Mean	*sd*	Hedges *g*
Outcomes					
Applied STEM certificate	0.02	0.12	0.01	0.10	0.01
Applied STEM associate's	0.02	0.13	0.02	0.14	0.01
Public Service certificate	0.01	0.08	0.01	0.10	0.06
Public Service associate's	0.02	0.14	0.02	0.15	0.02
Business & Marketing certificate	0.03	0.18	0.07	0.25	0.10
Business & Marketing associate's	0.03	0.17	0.04	0.19	0.02
Health Sciences certificate	0.08	0.27	0.12	0.32	0.08
Health Sciences associate's	0.03	0.17	0.03	0.16	0.05
Trades certificate	0.03	0.17	0.06	0.24	0.15
Trades associate's	0.01	0.09	0.01	0.11	0.01
Student-level controls					
Female	0.59	0.49	0.58	0.49	0.04
Race					
White	0.55	0.50	0.54	0.50	0.09
Black	0.17	0.37	0.15	0.36	0.01
Latinx	0.19	0.39	0.23	0.42	0.15
Asian	0.04	0.19	0.04	0.19	0.00
Other	0.05	0.23	0.04	0.20	0.06
Income < $25k	0.41	0.49	0.42	0.49	0.08
First-generation college student	0.74	0.44	0.74	0.44	0.04
Disability	0.12	0.33	0.13	0.33	0.01
Age at entry	23.93	9.02	21.42	6.68	0.21
Dual enrollment	0.17	0.37	0.22	0.41	0.11
Academic program					
Certificate program	0.19	0.39	0.17	0.37	0.09
Associate's program	0.67	0.47	0.77	0.42	0.03
Bachelor's program	0.01	0.11	0.05	0.22	0.18
Not in degree program	0.13	0.34	0.02	0.12	0.37
n	*5,900*		*4,180*		

Figures in Table 2 show that BPS:12/17 participants attended larger subbaccalaureate institutions, on average. This would be expected given aggregate postsecondary enrollment has increased over time. Small to modest differences in the sectoral composition of the subbaccalaureate institutions students attended in the two BPS cohorts are also observed (Cohen, 1988). Last, one can see that the number of degrees awarded in each of the five CTE cluster areas has increased over time, as would be expected. On the whole, Tables 1 and 2 illustrate some observable differences in individual- and institutional-level characteristics across the two BPS cohorts but the associated effect sizes suggest the vast majority of these differences are trivial and just a few can be considered modest. All of the modest differences between institutions can be explained by secular trends in college enrollment.

RQ1: Changes in CTE Participation by Field of Study

Table 3 contains the estimates generated from equation 1, which was designed to assess differences in the CTE completion outcomes across BPS cohorts, holding constant the variables listed in Tables 1 and 2 as well as observable and unobservable sources of between-state heterogeneity. The first three columns show BPS:12/17 participants were less likely than BPS:04/09 participants to earn subbaccalaureate associate degrees in Applied STEM but the differences in certificates and associate degrees are not statistically significant. Only the pooled "any credential" outcome is statistically significant but just so. Consequently, we are hesitant to draw firm conclusions from these estimates. By contrast, figures in columns 4–6 suggest BPS:12/17 participants had significantly higher probabilities of earning certificates and associate degrees in Business & Marketing compared to their BPS:04/09 peers. Figures in columns 7–9 indicate BPS:12/17 participants were statistically less likely to earn associate degrees in Health Sciences but were not more or less likely to earn certificates in the same CTE cluster. Figures in the remaining columns of Table 3 show that there did not appear to be an association between BPS cohort membership and subbaccalaureate completions in the Public Service and Trades CTE clusters. In other words, there was no evidence to suggest that completions in these fields of study had substantially changed over time after factoring in a range of individual- and institutional-level controls.

RQ2 and RQ3: Changes in CTE Field of Study Participation by Special Population

Tables 4–6 contain the estimates produced by equation 2 that included an interaction between the BPS cohort and special population indicators. Focusing first on Table 4, we see from the figures in Panel A, attendance at a rural institution across the full sample was only significantly associated with differences in credential earning (driven predominantly by associate degrees) within the Public Service cluster. However, none of the interactions between rural status and membership in the BPS:12/17 cohort were significant. In other words, rural students in the more recent cohort were neither

Table 2. Institution-Level Descriptive Statistics, by BPS Cohort

	BPS:04/09		BPS:12/17		
	Mean	*sd*	Mean	*sd*	Hedges *g*
Institution-level controls					
IPEDS: Rural-serving institution	0.12	0.32	0.11	0.31	0.03
IPEDS: 12-month unduplicated headcount (per 1000)	14.91	15.54	20.78	27.72	0.36
IPEDS: Underrepresented racial minorities (%)	34.54	26.52	36.53	22.57	0.09
Sector					
Public, 2-year	0.77	0.42	0.85	0.36	0.14
Private non-for-profit, 2-year	0.02	0.12	0.00	0.07	0.24
Private for-profit, 2-year	0.10	0.30	0.08	0.27	0.24
Public, less-than 2-year	0.02	0.14	0.02	0.13	0.19
Private not-for-profit, less-than 2-year	0.00	0.06	0.00	0.06	0.01
Private for-profit, less-than 2-year	0.09	0.29	0.05	0.21	0.25
IPEDS: Health Sciences degrees (per 100)	1.55	1.97	4.51	8.14	0.56
IPEDS: Business & Marketing degrees (per 100)	1.49	2.15	3.22	5.90	0.45
IPEDS: Communication & Information Sciences Degrees (per 100)	0.71	0.99	1.58	2.53	0.46
IPEDS: Industrial, Manufacturing & Engineering Systems Degrees (per 100)	1.97	2.92	3.29	5.07	0.47
IPEDS: Human Services Degrees (per 100)	1.57	2.49	2.67	3.31	0.47
n	*5,900*		*4,180*		

Table 3. Associations Between BPS Cohort Membership and CTE Completion by Field of Study

	Applied STEM			Business & Marketing			Health Sciences			Public Service			Trades		
	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred
BPS:12/17	−0.01	−0.00	−0.02*	0.04***	0.02*	0.06***	0.01	−0.01***	0.02	0.00	0.01	0.01	0.01	0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	10,080	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*

Note. Estimates derived using BPS sampling weights; cluster-adjusted robust standard errors in parentheses; *$p < .05$. **$p < .01$. **$p < .001$.

Cert = Certificate; AA/AS = Associate of Arts/Associate of Science; Any Cred = any credential; State FE = state fixed effects.

Table 4. Rural and Female Student Moderation Estimates

	Applied STEM			Business & Marketing			Health Sciences			Public Service			Trades		
	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred
Panel A: Rural Interactions															
BPS:12/17	−0.01	−0.01	−0.02**	0.04***	0.02*	0.06***	−0.01	−0.01***	−0.02	0.00	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Rural	−0.00	−0.01	−0.01	−0.01	−0.00	−0.01	0.00	0.01	0.01	0.01	0.02**	0.03*	0.01	0.02	0.03
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.03)	(0.02)
BPS:12/17*Rur.	0.00	0.02	0.03	−0.00	0.03	0.02	0.02	−0.02	0.01	−0.01	−0.03	−0.04	0.02	−0.03	−0.00
	(0.01)	(0.02)	(0.2)	(0.02)	(0.02)	(0.03)	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)	(0.03)	(0.04)
Panel B: Female Interactions															
BPS:12/17	−0.02	0.01	−0.01	0.03**	0.02	0.05**	−0.00	−0.01**	−0.02	0.00	−0.01	−0.00	0.01	0.01	0.02
	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)
Female	−0.02**	−0.03***	−0.05***	0.02***	0.00	0.02**	0.07***	0.04***	0.10***	−0.00	0.00	0.00	−0.06***	−0.01**	−0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)
BPS:12/17*Fem.	0.01	−0.02**	−0.02	0.01	0.01	0.02	−0.01	−0.00	−0.01	−0.00	0.02**	0.01	−0.01	−0.01	−0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	10,080	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*

Note. Estimates derived using BPS sampling weights; cluster-adjusted robust standard errors in parentheses; $^{*}p < .05$. $^{**}p < .01$. $^{**}p < .001$. Cert = Certificate; AA/AS = Associate of Arts/Associate of Science; Any Cred = any credential; State FE = state fixed effects; Rur = rural; Fem = female.

more nor less likely to earn credentials in any of the five clusters compared to their BPS:04/09 counterparts.

Results in Panel B of Table 4 present the interaction estimates for female students in the BPS cohorts. Estimates suggest that females in the sample were statistically less likely to earn Applied STEM credentials compared to male students. Furthermore, the statistically significant interaction suggests this gender gap has grown over time. More specifically, BPS:12/17 females were roughly 2 percentage points less likely than BPS:04/09 females to earn Applied STEM associate degrees. By contrast, even though BPS:04/09 females were roughly 2 percentage points more likely to earn certificates in Business & Marketing, there was no evidence to suggest this relationship had changed over time. Similarly, figures in columns 7–9 within Table 4 show that females were more likely than males to earn Health Sciences certificates and associate degrees, regardless of BPS cohort. With respect to Public Service, we do see a significant interaction coefficient for female students in the BPS:12/17 cohort. Specifically, females in the latter cohort were significantly more likely to earn an associate degree in this field than females in the earlier BPS cohort. Finally, there was no evidence to suggest the relationship between BPS cohort membership and Trades completions was different over time, though female students were significantly underrepresented in this field in general.

Figures in Table 5 contain the moderation estimates for low-income and URM students. While overall we see that there are not many significant interactions, there are a handful worth mentioning. In Panel A, while we do observe a significant interaction with respect to Business & Marketing for low-income students in the BPS:12/17 cohort, the actual coefficient (–0.04) is identical yet opposite to the coefficient (0.04) representing membership in the BPS:12/17 cohort, suggesting the net gain for low-income students in this category was essentially nothing. We see a similar pattern with respect to any credential earned in Business & Marketing, though here we see a coefficient for the BPS:12/17 cohort membership larger than that for the low-income interaction, suggesting that low-income students in BPS:12/17, while perhaps more likely than low-income students in BPS:04/09 to earn this credential, were actually falling behind their non-low-income peers in this regard. The only other significant interaction was associated with low-income students in the BPS:12/17 cohort earning Health Sciences associate degrees. Here, we observed a positive interaction, but the main estimates associated with BPS:12/17 and low-income separately were negative. Essentially, the main estimates and interaction cancel each other out in this case and suggests that, in contrast to low-income students in the BPS:04/09 cohort, low-income students in the BPS:12/17 cohort were not more or less likely to earn an associate degree in Health Sciences.

Figures in Panel B, by contrast, present results associated with URM status. Main estimates show that non-minority students in the BPS:12/17 cohort were less likely to earn Health Sciences associate degrees. Furthermore, main estimates show that minority students in the BPS:04/09 cohort were also less likely to earn Health Sciences associate

Table 5. Low-Income and URM Student Moderation Estimates

	Applied STEM			Business & Marketing			Health Sciences			Public Service			Trades		
	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred
Panel A: Low-Income Interactions															
BPS:12/17	−0.01	−0.01	−0.02	0.04***	0.04***	0.08***	−0.00	−0.02***	−0.03*	0.00	0.01	0.01	0.01	0.01	0.02
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
Low-income	0.00	0.01	0.01	−0.01	0.01	−0.00	−0.01	−0.02**	−0.02*	0.00	−0.00	−0.00	0.00	−0.00	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.01)	(0.01)	(0.00)	(0.01)
BPS:12/17*Low	−0.01	−0.01	−0.01	−0.00	−0.04***	−0.04**	−0.01	0.02**	0.01	−0.01	−0.01	−0.02	−0.00	−0.01	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Panel B: URM Interactions															
BPS:12/17	−0.01	−0.00	−0.02	0.03***	0.02*	0.03***	0.00	−0.02***	−0.02	0.01	0.00	0.01	0.01	0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)
URM	−0.00	0.00	−0.00	0.00	0.01	0.01	−0.00	−0.02***	−0.03**	0.00	−0.01	−0.01	−0.00	−0.01	−0.01
	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
BPS:12/17*URM	0.00	−0.01	−0.01	−0.00	−0.02	−0.02	0.00	0.02**	0.02	−0.01	0.02*	0.01	−0.01	−0.00	−0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	10,080	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*

Note. Estimates derived using BPS sampling weights; cluster-adjusted robust standard errors in parentheses; *$p < .05$. **$p < .01$. **$p < .001$; Cert = Certificate, AA/AS = Associate of Arts/Associate of Science; Any Cred = any credential; State FE = state fixed effects; Low = low-income; URM = underrepresented minority.

degrees. However, the positive interaction suggests that the negative predictive value of identifying as an URM has attenuated over time. Practically, the main and interaction estimates cancel each other out such that minority students in BPS:12/17 were not more or less likely to earn Health Sciences associate degrees. The only other significant change for this group of students is evident in Public Service. Here, the interaction is the only significant coefficient suggesting that URM students in the BPS:12/17 cohort were both more likely than their non-minority peers in the BPS:12/17 cohort to earn a Public Service associate degree and more likely than their URM counterparts in the BPS:04/09 cohort.

Figures in Table 6 contain the moderation estimates for SWDs. As one can see, SWDs in BPS:04/09 were slightly less likely to earn Business & Marketing associate degrees compared to students without disabilities, but there was no indication this differential had changed over time. By contrast, SWDs in BPS:12/17 were less likely than SWDs in BPS:04/09 to earn associate degrees in Health Sciences. Finally, we see that SWDs were less likely to earn Trades certificates in BPS:04/09. However, the positive interaction suggests that the negative association between SWD status and earning Trades certificates has diminished over time, across BPS cohorts. Indeed, the interaction term suggests SWDs in the BPS:12/17 cohort were more likely than their BPS:04/09 counterparts to earn a Trades certificate.

Discussion

The goal of this study was to explore the degree to which subbaccalaureate award completion among students in CTE fields of study have changed across two nationally representative samples of first-time college students. A secondary goal was to ascertain the degree to which any changes in CTE completion were moderated by special student population status. Prior research has associated CTE participation and completion with a range of positive academic and workforce outcomes. Unsurprisingly, there is growing support for CTE among policymakers who, in recent years, have made material changes to federal policy to broaden access to these programs. Yet, fundamental research gaps remain. The current study hopes to address this gap and, by extension, improve policy, practice, and research on a pressing policy topic.

Overall, our results indicate that subbaccalaureate completions in Applied STEM among students in our sample decreased from cohort to cohort. Further, this decrease was more severe for certain groups. Specifically, female students who were underrepresented in this field in the BPS:04/09 cohort became even more underrepresented by the BPS:12/17 cohort. In other words, the gap in Applied STEM associate degrees earned between male and female students actually grew over time. Similarly, Health Sciences earned credentials with respect to associate degrees also decreased over time. As with Applied STEM, there were some significant moderating factors worth considering with respect to this overall decrease. Specifically, low-income students and URM

Table 6. Students with Disabilities Moderation Estimates

	Applied STEM			Business & Marketing			Health Sciences			Public Service			Trades		
	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred	Cert	AA/AS	Any Cred
Panel A: Students with Disabilities Interactions															
BPS:12/17	−0.02	−0.01	−0.00	0.03***	0.02*	0.05***	0.00	−0.01**	−0.01	0.00	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
SWD	−0.00	−0.00	−0.01	−0.01	−0.01**	−0.02*	0.00	0.01	0.01	−0.01***	−0.01	−0.01*	−0.02***	0.00	−0.02***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.00)	(0.01)	(0.01)	(0.01)	(0.00)	(0.01)
BPS:12/17*SWD	−0.00	−0.02	−0.02	0.01	−0.00	0.01	−0.01	−0.03**	−0.04*	0.00	0.02	0.03	0.02*	−0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)	(0.02)	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
	10,080	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*	*10,080*

Note. Estimates derived using BPS sampling weights; cluster-adjusted robust standard errors in parentheses; *$p < .05$. **$p < .01$. **$p < .001$; Cert = Certificate; AA/AS = Associate of Arts/Associate of Science; Any Cred = any credential; State FE = state fixed effects; SWD = student with disabilities.

students had positive interaction estimates such that their Health Sciences associate degree earning did not decrease over time, but they were still underrepresented overall. Further, the gap in earned associate degrees in Health Sciences widened for SWDs compared to their non-disabled peers.

Finally, we did observe significant increases in Business & Marketing certificates and associate degrees. The estimates here had the largest magnitude across any of our five identified clusters. In this cluster, only low-income status presented a significant moderating estimate, and in this instance, it was negative. Specifically, while associate degrees in Business & Marketing increased overall, the gain was negated for low-income students. In other words, low-income students in BPS:12/17 were less likely to pursue an associate degree in Business & Marketing than their non-low-income peers.

Implications

While this study was motivated by recent changes to Perkins legislation, it was not able to draw causal linkages between these policy changes and CTE completion. Furthermore, we acknowledge that the estimates reported in this study are conditional on broader shifts in the composition of the community college student population. Nevertheless, the results do suggest a range of implications for policymakers, practitioners, and researchers. For policymakers, this study sheds much-needed light on the issue of whether recent changes to CTE policy are grounded. The two most recent Perkins reauthorizations have placed emphasis on the recruitment and retention of student populations historically underrepresented and underserved in postsecondary CTE. Our findings that the rate of completion in Applied STEM decreased across the two BPS samples contrasts with national policy goals to increase technical training in STEM-related CTE areas. That said, our finding that female students were increasingly underrepresented in Applied STEM does provide grounding and justification for the new policy mechanisms in Perkins V focused on broadening access and completion in CTE among special student populations. Like Carruthers et al. (2021), we found consistent evidence that segregation in postsecondary CTE fields of study reflect broader segregation in the labor market.

The Health Sciences are another area in which our findings present interesting policy-related implications. The decrease in earned associate degrees in Health Sciences fields among students in our sample is concerning, particularly given the shortage of qualified healthcare workers. However, that low-income students and URM students did not see this overall decrease presents a slightly more optimistic outcome given federal policymakers' desire to broaden access to, and completion in, in-demand fields of study. Yet on the other hand, the most remunerative and stable careers in healthcare increasingly require advanced degrees, including associate and bachelor's degrees. That rates of associate degree completions declined among students in our sample overall, and for SWDs in particular, is concerning and warrants further investigation.

Of note, Perkins IV, while emphasizing the need to increase access to, and participation in, high quality CTE programming for students from special populations, did not include specific policy or funding mechanisms or provide any guidance as to how best to accomplish this goal. As such, it is perhaps not terribly surprising that there were not any general increases in participation across all groups in our data. Further, Perkins IV emphasized the integration of science and math knowledge with technical skills. With this goal in mind, it is disheartening that we observed students in the more recent BPS:12/17 cohort were less likely to earn an Applied STEM credential than students in the earlier cohort. That female students were even less likely than their male counterparts in the BPS:12/17 cohort to earn an Applied STEM associate degree shows that while there may have been good intentions in the Perkins IV legislation, there was little evidence that these good intentions have yet to come to fruition using the data we had available.

It is quite likely that the fact we did not observe growth in special population participation is due to the lack of a policy lever in Perkins IV to push this agenda. Perkins V, authorized in 2018, did make an attempt to address this issue through a required set aside to be used for recruitment of students from special populations. While it is laudable that the federal government recognized this need, there is a lack of clarity as to what exactly this set aside should fund or guidance as to how best to recruit students into CTE programs, and the amount of the set aside is quite limited as to what is actually required. This remains an oversight and will hopefully be addressed in future iterations or through state-level policies.

For practitioners, the current study underscores the importance of, and continued challenges with, recruiting special populations into CTE fields of study at the post-secondary level. Even though policymakers have placed an emphasis on recruiting historically underrepresented student populations into CTE fields of study, the current study illustrates that CTE pipelines continue to be stratified. Importantly, prior research has found that national trends in CTE uptake do not necessarily generalize to localized contexts (Carruthers et al., 2021). For example, in their multistate analysis of CTE trends, researchers with the Career and Technical Education Policy Exchange found that CTE course taking varied across states, and the trends within each state were reflective of the schools students attended and local factors (Carruthers et al., 2021). Nevertheless, practitioners wanting to investigate CTE participation among special populations can use the current study as a starting point to begin their own inquiries using local data sources. Secondly, practitioners can use the findings of the current study to inform their efforts to recruit special populations into local CTE programs of study. For example, CTE providers hoping to recruit female students into Applied STEM fields of study can use the current study as a baseline for which to draw comparisons and contrasts to their own rates of participation. On a technical level, the current study also illustrates methodologies practitioners can replicate for tracking CTE participation over time and by special population status.

For researchers, this study should inspire future examination. Our work highlights the importance of viewing CTE not as a monolith, but rather as a set of unique pathways. Our study used two nationally representative samples of students; however, researchers with access to state administrative data would be in a position to carry out more highly-powered analyses and to better observe changes in each of the 16 individual clusters. Future research should also consider the transition from postsecondary education to career and whether students are finding employment in fields aligning with their credentials.

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