

Students with Disabilities in Massachusetts Career and Technical Education Programs

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Introduction

Career and Technical Education (CTE) has a long history in the United States and in Massachusetts in particular, where it has existed as a formal educational pathway for over a century. Today, more than 100 schools in Massachusetts offer CTE programs, which enroll approximately eighteen percent of all secondary-school students in the Commonwealth. Despite existing evidence that CTE can provide educational benefits for students (Plank, Deluca, & Estacion, 2008 ; Kelly & Price, 2009), there have been no rigorous inquiries into the potential effects of CTE in Massachusetts. Students with disabilities represent approximately 25% of students enrolled in Massachusetts CTE programs. Understanding the impact of CTE participation is particularly important for these students given their comparatively low-rates of high-school graduation across the commonwealth.

CTE programs were originally created as a way to offer meaningful secondary education pathways that prepared students for the types of employment available in their communities. In addition to providing access to instruction in core academic subject areas (English, mathematics, science, and social studies) these programs also offered training and certifications in skilled professions such as plumbing, cosmetology, biotechnology, information technology, and metal fabrication. Beginning in the 1990s, educators began referring to these programs as “career and technical education” rather than “vocational education,” to reflect the inclusion within CTE of content areas that historically were not considered “vocational,” and the fact that “vocational education” carried a stigma that was often associated with the funneling of lower-achieving students into these programs. Despite this legacy of stigma CTE has the potential to offer a variety of benefits for students, such as opportunities for situated learning that have direct application to “on the job” situations. In addition, whether or not students plan to pursue a profession that will employ the skills they develop in these programs, the applied nature of the shop-based instruction provides an avenue for engagement and relevance that is often missing in traditional college-preparatory curricula.

CTE may be especially beneficial to students with disabilities because the smaller student-teacher ratios in CTE classrooms provide an opportunity for students to work closely with instructors, and CTE instruction uses multiple modalities of learning that may engage areas of particular strength for students with disabilities. Furthermore, data from the National Longitudinal Transition Study¹ (NLTS) indicate that students with disabilities who attended vocational education programs had higher employment rates and higher salaries five years after high school graduation (Wagner, et al., 1993).

Therefore, it is important for students with disabilities across the commonwealth to have access to CTE programs. Under state law, and by design of the educational system, all students have access to some form of CTE, either through their home district, school choice, or access to a regional vocational and technical school. Because the commonwealth has mandated that all students have access to this educational pathway, it is important that DESE know whether students with disabilities across categories are reasonably represented in these programs, and

¹ See <http://www.nlts2.org/index.html> for full description of NLTS study design and findings.

whether these programs do indeed provide an equal or better benefit to these students than traditional academic programs.

Types of Schools Offering CTE Programs in Massachusetts

Under Massachusetts law and the Federal Perkins IV Act, all students in the Commonwealth must have access to some form of CTE education. The Commonwealth of Massachusetts provides an additional level of approval for some of its programs, the Chapter 74 Approved designation, which certifies and funds programs that meet a more stringent set of standards in addition to the standards developed for Federal funding provided to Perkins-only programs. For the purpose of our analyses, we grouped the CTE programs in schools across the Commonwealth into four distinct categories. We based these categories on differences in requirements for funding and certification provided by each, the availability of these programs based on district of residence, as well as conversations with superintendents and principals from across the Commonwealth about the distinct experiences of students in the different types of programs.

- (1) *Regional Vocational and Technical Schools (RVTS)*. In this category we combine two broad types of schools. The first broad group is *regional vocational and technical schools*, where the entire student body participates in some form of CTE and where students are drawn from several surrounding communities. The second broad group included in this category are *county and statewide agricultural schools*, which look very much like the regional vocational and technical schools but, with a greater focus on agriculture, horticulture, and environmental science. In this report we will refer to both agricultural and regional schools as Regional Vocational and Technical Schools (RVTS). Altogether, 29 schools are included in this category.
- (2) *City Vocational and Technical Schools (CVTS)*. There are five *city vocational and technical schools* in the Commonwealth of Massachusetts. As with their regional counterparts, all students in these schools participate in some form of CTE. The distinction between these schools and their counterparts in category (1) is that students here originate solely from the specific city in which the given school is located, rather than drawing from several municipalities. These schools exist in five major cities in the Commonwealth: Boston, Holyoke, Lynn, Springfield, and Worcester.
- (3) *Chapter 74 Approved CTE Programs Embedded in Traditional High Schools*. This category of programs is offered within traditional public high schools. These therefore differ from *RVTS* and *CVTS* programs in that, within each school, only a portion of all students participate in the embedded CTE program(s). To distinguish further among traditional public high schools that offer CTE programming, schools in this particular subset contain CTE programs that meet a set of requirements that have earned them Chapter 74 approval, a distinction that indicates that the program meets a number of requirements above and beyond those required to receive federal funds through the Perkins IV act. These requirements include the establishment of advisory committees comprised of educators, employers, and members of organized labor to

make decisions about the direction of the program. This category includes CTE programs offered in a variety of settings in 42 different schools.

- (4) *Perkins-Only CTE Programs Embedded in Traditional High Schools*. Programs in this category represent the remainder of CTE programs within the category of traditional public, high schools with embedded CTE programming. In these schools, the CTE programs, in which, again, only a portion of all students participate, have not met the requirements for Chapter 74 approval. Instead, these CTE programs meet only the federal guidelines for funding through the Perkins Act, but not the guidelines for Chapter 74 approval. We include in this category programs housed in 67 different schools. NOTE: it is possible for a given traditional high school to offer both chapter 74 approved and Perkins-only CTE programs.

Research Goals

In our analysis, we sought to determine the degree to which Massachusetts students with disabilities participate in career and technical education programs, and how rates of participation differ across disability categories, school types, and instructional “shops.” We then examined the school performance of students with high incidence disabilities² who were enrolled in CTE programs in comparison with the performance of similar Massachusetts students enrolled in non-CTE high school programs. We measured school performance in two ways: (1) four-year high school graduation rates; and (2) scores on the state-wide Massachusetts Comprehensive Assessment Systems (MCAS) tests.

Summary of Findings

We find that students with disabilities participate in CTE programs at relatively high rates, but that there were notable differences in CTE participation both by disability category and by school type. We find strong evidence that students with high-incidence disabilities who attended *regional vocational and technical schools* graduate from high school in four years at substantially higher rates than students with high-incidence disabilities who attended traditional high school programs. Specifically, taking into account factors that are relevant to student performance including student sex, race, free- or reduced-price lunch eligibility, English Language Learner (ELL) status, specific disability type, median income of a student’s town of residence, middle-school performance on the MCAS, school attendance, and suspension data and access to these schools, we found that the odds of successful four-year graduation for a student with a high-incidence disability in a *regional vocational and technical school* are approximately 1.7 times the odds for a similar student enrolled in a traditional public school.³ Despite the clear benefit of *regional vocational and technical school* participation for students with high-incidence disabilities, we did not find statistically-significant differences in the MCAS performance of

² In this report, “high incidence” refers to students identified as having a specific learning disability, communication disability, or other health impairment.

³ See appendix A for explanation of statistical control.

CTE students with high-incidence disabilities when compared to their counterparts in traditional high school programs.

Detailed Findings for CTE Participation among Students with Disabilities in Massachusetts by Disability Category and School Type

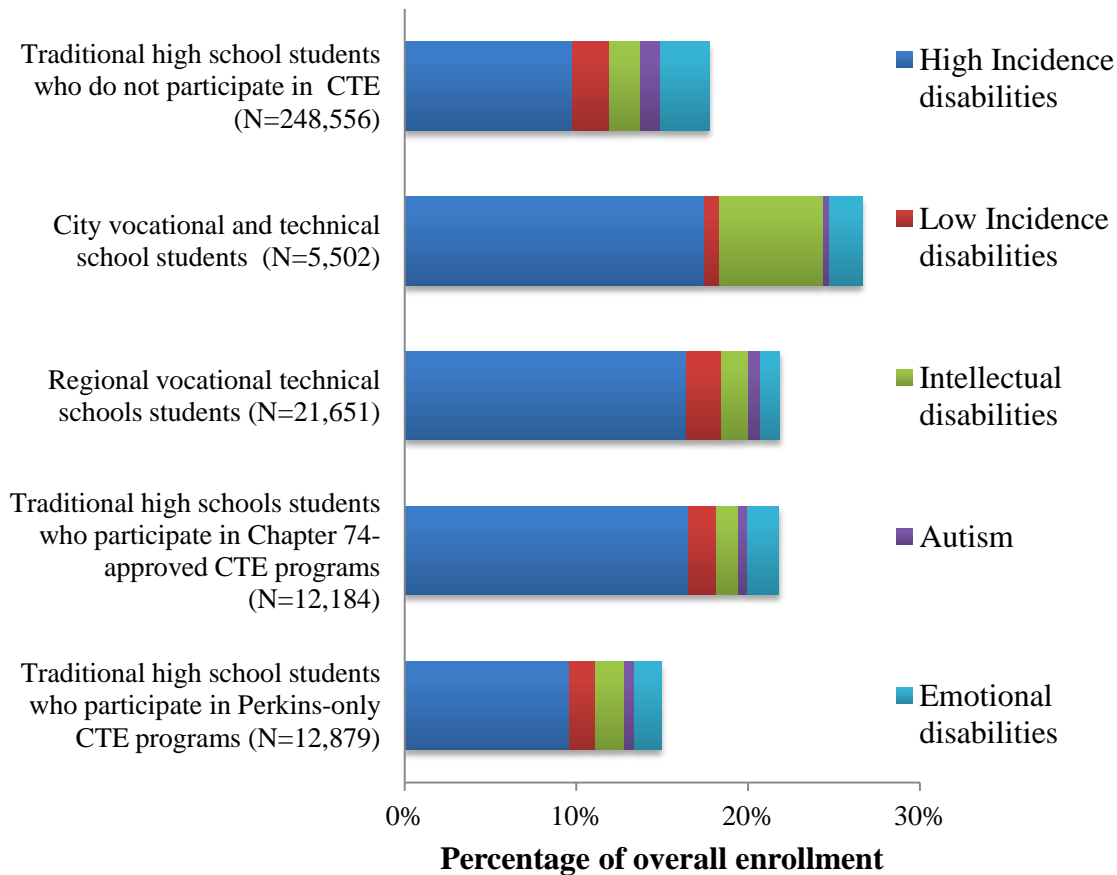
In our analysis, we examined the degree to which Massachusetts students with disabilities participate in career and technical education programs, and how rates of participation differ across disability categories, program-types, and students' vocational "shops."

Finding 1a: Students with disabilities enroll in CTE programs at disproportionately high rates

On average, students with disabilities enroll in CTE programs at substantially higher rates than they enroll in traditional high school programs. This is particularly true for students with high-incidence disabilities (defined as students with learning disabilities, communication disabilities, or other health impairments). Although students with high-incidence disabilities make up approximately 10% of the student population in non-CTE settings, they participate in both *regional* and *city* CTE programs at considerably higher rates (representing approximately 16% and 17% of students, respectively).

This relatively high rate of participation in CTE programs is not evident for students from lower-incidence disability categories. For example, students with Autism represent a lower percentage of students across all CTE programs (0.6%) than they do in traditional high schools (1.2%). Similarly, students with emotional disabilities enroll in *regional vocational and technical schools* at less than half the rate (1.1%) at which they enroll in traditional high schools (2.8%). Patterns of enrollment for several disability categories across all four types of CTE programs are displayed in Figure 1 below.

Figure 1: Percentages of enrolled students by disability category for traditional high schools, City Vocational and Technical Schools, Regional Vocational and Technical Schools, Traditional High Schools with Chapter 74 Approved CTE Programs, and Traditional High Schools with Perkins-Only CTE Programs.⁴



Finding 1b: There are substantial differences within and between in CTE programs in the enrollment of students with disabilities.

Although Massachusetts career and technical education programs do, on average, serve higher proportions of students with disabilities when compared to traditional high schools, this average difference is not distributed evenly across all CTE programs. In fact, there are substantial school-to-school differences in enrollment patterns for students identified in different disability categories. For example, some vocational schools or programs enroll few or no students with

⁴ The “High Incidence” category includes students with Learning disabilities, Other Health Impairments, & Communication disabilities. The “Low incidence” category includes students with Neurological impairments, Multiple disabilities, Physical disabilities, & Sensory impairments.

low-incidence disabilities, such as physical or sensory disabilities, while other programs enroll these students at rates that far exceed their overall representation in the population.⁵

General Trends in Regional Vocational and Technical Schools

Although school-to-school differences exist, there are trends and patterns within program types that are worth noting. For example, within the category of *regional vocational and technical schools*, the majority of schools enroll students with low-incidence disabilities at disproportionately low rates. For example, there are RVTS programs that enroll zero students from eight out the twelve disability categories. It is notable that 23 of the 29 RVTS programs enroll zero students with physical disabilities, six schools do not serve any students with either physical or multiple disabilities and two schools do not serve a single student identified in either the Auditory, Vision, Deaf/ Blind, Physical or Multiple Disability categories. Students with Intellectual disabilities represent less than 1% of the student body in more than one out of three RVTS programs. Sixteen RVTS programs enroll students with Autism at rates lower than traditional high schools (0.5%) and seven of those schools also have lower percentages of students with intellectual disabilities than are found in the overall population of Massachusetts high school students (1.5%). These data suggest that access to some RVTS programs is limited for students with low-incidence disabilities.

General Trends in the Five City Vocational and Technical Schools

When compared to the RVTS programs, *City Vocational and Technical Schools* (CVTS), on average, enroll a higher percentage of students with disabilities. Interestingly, this higher overall percentage is driven by substantially higher percentages in just 4 of the 12 disability categories. As a whole, CVTS serve higher percentages of students with Intellectual, Vision, Emotional, and Learning Disabilities, while *regional vocational and technical schools* serve larger percentages of students in all other disability categories. There is also substantial variability in the characteristics of enrolled students within the CVTS category. Holyoke serves the largest percentage of students with disabilities, particularly students with intellectual disabilities, which represents nearly 13% of their total enrollment. In Springfield, by contrast, students with Intellectual disabilities represent only 1.2% of total enrollment. Among CVTS programs, Worcester serves the lowest percentage of students with disabilities (20% of total enrollment), yet has a relatively high (5.2%) enrollment of students with Intellectual disabilities.

General Trends in Traditional Schools with Embedded CTE Programs

We observe similar school-to-school differences in CTE programs that are embedded in traditional high schools. In some high schools, such as Charlestown High School in Boston, nearly all of the students enrolled in vocational education are students with disabilities. In others, such as Algonquin Regional High School the opposite is true, with few students with disabilities in the CTE program. Among the 43 traditional high schools that offer both chapter 74 and non-chapter 74 CTE programs, there are no clear patterns of differential enrollment for students with and without disabilities. In other words, there is no evidence that within a given school, students

⁵ In at least some cases this is the result of specific programs embedded in these schools with the purpose of serving students with more severe disabilities.

with disabilities enrolled in CTE are more or less likely to receive chapter 74 (as compared to non-chapter 74) approved instruction.

Finding 1c: Students with disabilities enroll in a wide variety of vocational programs with some clustering in certain areas.

There is a long-held belief that students with disabilities are shuttled into vocational programs or “shops” that prepare them to work predominately in low-paying custodial, kitchen, and horticultural positions. Our analyses suggest that this belief is not completely warranted. Students with intellectual disabilities do represent a higher percentage of enrollments in the horticulture, culinary arts, and facilities management shops than they do in the overall population of students in CTE programs, but these are not by any means the only shops in which these students are enrolled. Across all shops, there are approximately 4.6 non-disabled students for every student with a disability. In some shops such as Drafting, Medical Assisting and Stationary Engineering there are more than 9 non-disabled students for every student with a disability. In others such as Appliance Installation/Repairing, Sheet Metalworking, and Power Equipment Technology the ratios of non-disabled to disabled students are less than 2 to one. We do not find that similarly high rates of students with disabilities among students in the custodial, kitchen, and horticultural shops. Notably, there is no correlation between the ratio of disabled to non-disabled students in a given CTE shop and Bureau of Labor Statistics (BLS) estimates for the median hourly wages in that profession.⁶ Simply put, there is no evidence that, as a whole, students with disabilities are shuttled into less lucrative shops than their non-disabled counterparts. This pattern is consistent when we look at students with low-incidence and high-incidence disabilities separately.

Summary of Findings for Student Participation in CTE Programs by Disability and School Type

The variability in participation rates of students with disabilities overall, and in particular disability categories across RVTS may warrant some investigation of application and admissions policies to ensure that all students receive fair opportunities to access these resources. Similarly, the policies for recommending or assigning students to attend the *City Vocational and Technical Schools* may also warrant greater investigation. When taken as a whole, Massachusetts career and technical education programs serve a large percentage of students with disabilities. Yet when we look more closely, we find substantial differences in enrollment within and between types of career and technical education programs. The potential causes of this are numerous and cannot be determined with this analysis. The characteristics of local economies likely impact school’s decisions to offer particular CTE areas of study and likely also impact the patterns of participation in CTE for students with disabilities. The relationships that exist between sending schools and towns and their shared high schools or RVTS may also influence these patterns.

⁶ BLS estimates available here http://www.bls.gov/oes/oes_dl.htm

Detailed Findings for the Academic Performance of Students with High-Incidence Disabilities in Massachusetts Career and Technical Education Programs

In this section we focus only on students identified as having high-incidence disabilities, such as learning disabilities, communication disabilities, or other health impairments. We do this because students with high incidence disabilities, in general, have similar overall cognitive capacities as non-disabled students and are typically assessed using the standard forms of the Massachusetts Comprehensive Assessment System tests. We examine the school performance of these students in CTE programs in comparison with the performance of similar students enrolled in traditional public schools. We first report findings for the four-year graduation rates of these students and then detail trends in their scores on the MCAS.

Finding 2: Students with high-incidence disabilities in Regional Vocational and Technical Schools, are more likely to graduate from high school within four years than similar students who do not participate in any CTE education in high school, or who participate in Perkins-only approved programs.

In our full sample of students, comprising 142,079 students in 368 high schools, we see, descriptively, that the percentage of students with high-incidence disabilities who do not participate in CTE programs, graduate from high school on time at a rate of about 70%. Among students who do participate in CTE programs, students with high-incidence disabilities enrolled in *regional vocational and technical schools* graduate on-time at a rate of 84%; in *traditional high schools with Chapter 74 approved CTE Programs*, at a rate of 65%; in *traditional high schools with Perkins-only CTE programs*, at a rate of 58%; and in the *city vocational and technical schools*, at a rate of 78%.

These data indicate that students with high-incidence disabilities who attend *regional vocational and technical schools* graduate on-time at higher rates than their peers who enroll in other types of CTE programs. However, these observed rates do not take into account important differences in the background and experiences of these students that may drive the observed differences in graduation rates. To adjust for these differences and obtain a clearer view of the unique contribution of CTE program type to students' graduation rates, we fit a series of multi-level logistic regression models where we estimated the likelihood of on-time graduation while taking into account, or controlling for, a variety of student and town characteristics. Among these characteristics were sex, race, free- or reduced-price lunch eligibility, ELL status, specific disability type, median income of a student's town of residence, and middle-school performance on the MCAS, school attendance, and suspension data.⁷ By controlling for these characteristics,

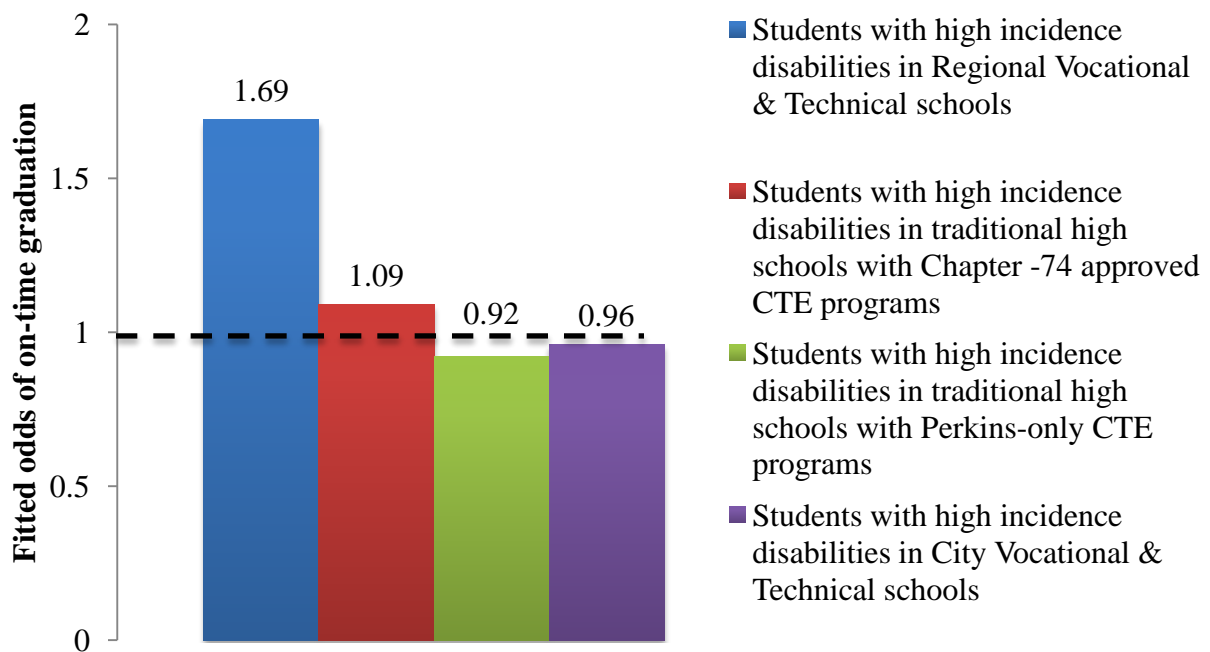
⁷ These covariates differ slightly from those used in our previous study of students with disabilities in Massachusetts. Here, we also include information on student's middle-school test scores, incidence of suspension, and attendance because these factors are used to determine a student's eligibility to attend a *regional vocational and technical school*. Including these covariates increases our confidence in the comparisons we can make between *regional vocational and technical schools* and students in any other setting.

we can better isolate the unique impact of participating in CTE on a student’s likelihood of high school graduation.⁸

Results from these statistical analyses demonstrate that students with high-incidence disabilities who attend a *regional vocational and technical school* have substantially higher odds of on-time graduation than similar students who do not participate in CTE, or who participate in either a Chapter 74 or Perkins-only CTE program in a *traditional* school. Taking into account other factors that are related to the likelihood of graduation, the estimated odds that a student with a high-incidence disability will graduate from high school within four years of 9th grade matriculation at a *regional vocational and technical school* are 1.69 times the odds for a similar student who did not attend such a school.

Although this relationship existed for *regional vocational and technical schools* in our models, we did not find the same pattern for students who participated in other types of CTE programs. For instance, students with high-incidence disabilities in *traditional schools* (whether in a Chapter 74 approved CTE program or a Perkins-only program) are no more likely to graduate from high school on time than their peers who do not participate in a CTE program. As for students in the five *city vocational and technical schools*, we found no added benefit to attending these schools with respect to high-school graduation outcomes. The fitted odds ratios from our statistical models for the different CTE programs are displayed together in Figure 2 below.

Figure 2: Fitted odds ratios of graduating on-time (within four years) from high school for students participating in different CTE programs, compared to students not participating in those programs. *Note:* A fitted odds ratio of 1 represents even odds (no better, no worse).



⁸ Additional information regarding these statistical analyses is provided in the attached appendix.

Finding 3: There are no statistically significant differences in MCAS performance for students with high-incidence disabilities who do and do not enroll in Massachusetts CTE programs.

Students with high-incidence disabilities in *regional vocational and technical schools*, on average, perform no better or no worse on the ELA and mathematics portions of the MCAS compared to similar students in traditional public high schools. These findings are drawn from multi-level ordinary least squares regression models in which we controlled for student's prior attendance, discipline data, and academic performance, as well as student demographic characteristics

Because Massachusetts requires passage of the MCAS as a precondition for high-school graduation, students' scores on MCAS and graduation rates might be expected to be related. For this reason, it may seem counter-intuitive that although we found differences in the likelihood of on-time high school graduation for RVTS students, we found no significant differences in MCAS performance for these same students. However, the average performance of students with high-incidence disabilities in RVTS exceeds the score that corresponds to passing the MCAS for graduation purposes. Therefore, we are not surprised that higher odds of graduation correspond to modest or no differences in MCAS performance. That said, the non-difference in MCAS performance between RVTS and traditional high school students is noteworthy for another reason: students in RVTS spend roughly half of the time in traditional academic coursework that their counterparts spend in traditional academic programs housed in traditional high schools. Achieving comparable performance on the MCAS of CTE and traditional high school students is therefore impressive, and may underscore the effectiveness of the applied instruction in RVTS.

Conclusion

Our analysis of the academic performance of Massachusetts students with high-incidence disabilities in CTE programs helps paint a picture of the benefits to students participating in these programs. We found patterns in the performance of these students by different CTE program types that can be useful in guiding policies that affects these schools.

The regional vocational and technical schools, including agricultural schools, appear to be doing a commendable job with a significant number of their students with high-incidence disabilities. Each year approximately 84% of these students graduate on time with MCAS diplomas compared to only 68% of similar students outside of regional vocational and technical schools who graduate on time. Indeed, students with high-incidence disabilities in *Regional Vocational and Technical Schools* have significantly greater odds of on time graduation than their counterparts in traditional high schools. Though we are unable to verify with current data, we believe that these students are more likely to be employed as well. It should also be noted that even though these students spend approximately half the amount of time in classes that support traditional academic subjects as their peers enrolled in traditional high schools, they nonetheless perform at comparable levels on MCAS tests.

Students in *Chapter 74 approved CTE Programs* embedded in a *traditional high school* do not appear to graduate at rates higher than those in Perkins-only programs and those in traditional high school programs. Additionally, when considering all city vocational and technical schools

together, students in these schools do not appear to enjoy the same on-time graduation benefits as those in regional vocational schools.

Plausible Explanations for the Higher Likelihood of On-Time Graduation for Students with High-Incidence Disabilities in Regional Vocational and Technical Schools

Although the data we used in our analyses does support modeling odds ratios for on-time graduation of students with high-incidence disabilities enrolled in regional vocational and technical schools, it is not possible with this data to determine *why* these students have a higher likelihood of graduating in four years than comparable students in traditional public high schools. However, we explored this question by speaking to a number of CTE educators across all settings regarding our findings and heard remarkably consistent explanations for this success. We have generated several plausible hypotheses based on these discussions.

First, educators from these schools attributed engagement as a major factor in retaining students and graduating them on time. Many told stories of students who, having previously struggled with school, were able to find their niche in vocational schools. Stories of students who not only persevered but excelled in their vocational areas were readily offered. This is consistent with the literature on Universal Design for Learning, which posits that engagement is a central feature of successful learning environments for many diverse learners (Rose and Myer, 2002).

The relative success of many students with disabilities in vocational schools also makes sense given what we know about these students, particularly those with learning disabilities or behavioral issues. For instance, research that suggests that students with dyslexia may also excel in areas that rely on “big picture” and creative thinking (Shaywitz, 2003). We posit that the additional time students in *regional vocational and technical schools* spend in their shops, as well as an alternating schedule, which allows for one week in the classroom, one week in the shop, may foster such “big picture” and creative thinking in a way that part-time programs in traditional schools are less able to facilitate.

In regard to why these students appeared to perform comparably in academics even though they have much less time in academic subjects, most CTE educators indicated that the strong connection between vocational and academic subjects may account for of this finding. For instance, one educator stated they used math constantly in their vocational areas.

In response to our finding that Chapter 74 programs in traditional schools do not appear to have the same impact on graduation rates as regional vocational schools, several educators speculated that the difference may be due to the “stigmatization” vocational education has in some traditional high schools. We concur that students with disabilities and students who participate in CTE in traditional settings may face possible stigmatization by their peers for carrying either of these labels. Regional vocational and technical schools do not suffer the effects of within-school stigmatization, and we hypothesize that the larger share of students with disabilities in these settings may also lessen the stigma sometimes associated with disability. Further exploration of the practices used to engage and educate students with high-incidence disabilities in regional vocational and technical schools may provide fruitful policy options to improve the graduation-related outcomes of CTE participants in traditional schools.

In regards to the city vocational high schools, each should be viewed individually. As we have noted, the data on Worcester were quite similar to the RVTS programs. The others, however, did not. Holyoke's population of students with disabilities approaches 50%, and Boston's Madison Park/ORC has a history of varied approaches. One administrator in a city with vocational high school described the school as a "dumping ground." The varied histories and contexts of each of these schools suggest that an individualized approach to understanding differences and enrollment patterns for students with high incidence disabilities would be appropriate.

Though the RVTS serve many students with disabilities well, we are concerned that some schools have relatively low enrollments overall and that students in some disability categories are under-represented in RVTS programs. Of particular concern is the relatively low level of enrollment of students with emotional disabilities in RVTS. These students enroll at half the rate that would be predicted by the prevalence population. These students experience the poorest outcomes among students with disabilities and have very high drop out rates. In contrast, many of these students are successful in RVTS. It appears that some schools lack the capacity or the willingness to serve more of these students. We are also concerned that, though they represent a small percentage of the population, students with low-incidence disabilities such as blindness or deafness are not served at all in some RVTS programs.

Recommendations

Based on these findings we recommend that the Massachusetts Department of Elementary and Secondary Education take the following actions:

- (1) Identify high performing vocational schools that have been successful in educating diverse populations of students with disabilities to serve as models for others. Our exploratory work suggests that, among RVTS there are a number of schools that are performing at a high level with low drop out rates and strong academic and vocational outcomes. There is obviously much to be learned from these schools that could inform other high schools in their efforts to improve outcomes for students with disabilities.
- (2) Ensure equal access to vocational education. The wide disparities in enrollment of students with disabilities between RVTS and the relatively low participation of students with low incidence disabilities across CTE schools raise questions concerning access. The Department of Elementary and Secondary Education should monitor enrollment in these schools to ensure equal access of students with disabilities.
- (3) Consider expanding the capacity for providing high quality vocational education in areas where there is high demand.

Though access represents a concern, it should be emphasized the RVTS serve a large population of students with disabilities. Ensuring equal access to RVTS alone will not expand the capacity of these schools to serve all students with disabilities who seek enroll in an RVTS. However, many more students with disabilities could benefit from the type of high quality vocational education many RVTS appear to be offering. The current RVTS system was developed decades ago, and the demographics and employment needs of the Commonwealth have undoubtedly

changed. In general RVTS located in areas of high demand have lower enrollment of students with disabilities than those in areas of low demand. It would be short sighted to simply enroll more students with disabilities in these schools as that would deny others access. There appears to be a clear need to expand capacity in a number of areas of the state. The Commonwealth has experience with expanding capacity to meet demand in the charter school sector. The same principle should apply here.

Students with disabilities, particularly those with learning disabilities and those with behavioral issues, have a much higher likelihood of dropping out of school than their nondisabled counterparts. These students with disabilities who drop out of school are less likely to return to education and experience poorer adult outcomes such as higher unemployment levels, more problems with law enforcement, and greater levels of reliance on public assistance (Wagner, et al., 1993, Wagner et al., 2003). The RVTS role in providing greater numbers of these students with effective high school educations likely has positive implications for both individuals and society.

Appendix

Additional Methodological Information

Throughout this report we refer to findings drawn from a variety of statistical techniques. In this appendix, we detail the types of analysis we used to answer each research question, and then provide examples of the actual models we fitted that were used to form the findings reported in the body of this report.

Further inquiries about the methods and models can be directed to Shaun Dougherty shaun_dougherty@mail.harvard.edu

Access to programs

To compare rates of the enrollment rates of Massachusetts students with disabilities in career and technical education programs we examined the distributions of enrollment, paying attention to measures of central tendency and variability (mean, median, mode, standard deviation, etc.) of students in all disability categories in different types of CTE and non-CTE placements. These data came from the 2012 Massachusetts SIMS.

Odds of on-time graduation

We used multi-level logistic regression models to estimate the odds that students in different CTE and non-CTE settings Massachusetts would graduate on-time from high school.

Logistic regressions estimate the probability that an event will occur (for example, a student with a high-incidence disability in a regional vocational school will graduate from high school), while taking into account a variety of factors that might play into whether or not the event occurs (for example, the student's socioeconomic status or the financial resources of the student's home town, both of which are known to be related to the probability that a student will graduate from high school).

By using multi-level logistic regression models, we were able to estimate the odds that students' graduate (logistic regression), while also estimating and taking into account the role played by student- and district-level characteristics (through multi-level structure of the model) on the odds of graduating.

This process allowed us to understand, on average, the portion of the odds of graduation that was uniquely associated to specific student- or district-level characteristics (for example, the estimated odds, on average, that a student with a high incidence disability in Massachusetts would graduate from high school), taking into account the role that factors such as socioeconomic status, gender, students' eligibility for free/reduced-price lunch, prior test performance, prior school attendance, and prior instances of suspension from school play in a student's odds of graduating from high school.

These logistic regression models yielded estimates that allowed us to generate odds ratios, which we used to describe differential probability patterns of graduation from high school related to student exposure to several CTE settings. Essentially, odds ratios compare the odds of an event occurring to the odds that the event will not occur. Put more plainly, odds ratios compare the

likelihood of occurrence between two different events (for example, the likelihood that a student with a high-incidence disability *at regional vocational and technical school in Massachusetts* will graduate on-time from high school compared to the likelihood that a *student with a high-incidence disability who does not attend a regional vocational and technical school in Massachusetts* with similar characteristics such as socioeconomic status, gender, eligibility for free/reduced-price lunch, etc., will graduate on-time from high school.

A practical guide to interpreting odds ratios is as follows: *a)* if the value of an odds ratio is less than 1, then the event (for example, a *RVTS attendee* graduating from high school on-time) is less likely than its comparison event (for example, a *non-RVTS attendee* graduating on-time from high school); *b)* if the value of an odds ratio is equal to 1, then the event of interest is just as likely to occur as its comparison event; *c)* if the value of an odds ratio is greater than 1, then the event is more likely than its comparison event.

In comparing between members in a group of odds ratios, lower values represent lower likelihoods and higher values represent higher likelihoods; so an odds ratio of 1.7 represents a higher probability of identification than an odds ratio of 1.4, and an odds ratio of 0.3 represents a lower probability of identification than an odds ratio of 0.7.

MCAS performance

We used multi-level Ordinary Least Squares regression models to analyze the relationships between student and district characteristics on student scores on the English and Mathematics MCAS tests. The use of multi-level models allowed us to account for similarities in the performance of special education students that might be related to their enrollment in schools within the same district, thereby providing a clearer picture of the variability in achievement that was uniquely related to a student's proportion of time in mainstream settings.

In these models, we used dichotomous variables to represent students enrollment in a regional vocational and technical school, a separate dichotomy for Chapter 74 programs in traditional schools, a third dichotomous variable for participation in Perkins-only programs in traditional schools, and a fourth dichotomous indicator of whether a student attended a city vocational and technical school with students who do not participate in CTE as the reference category. In all instances we used a student's participation in one of these programs in ninth grade as the measure of exposure. Here we controlled for student gender, race, attendance rate in eighth grade, suspensions in eighth grade, MCAS performance in eighth grade, free/reduced-price lunch eligibility, ELL status, and average household income in a student's town of residence. This allowed us to estimate the difference in special education student performance on the MCAS associated with these different forms of CTE enrollment in comparison to children enrolled in programs that did not involve any CTE instruction.