



Following Virginia's Career and Technical Education completers out of high school and into college

A study of high school graduates' college enrollment, persistence, and completion

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<http://vlds.virginia.gov/media/2478/ctepostsecondary.pdf>.



Contents

Table of Figures.....	ii
Executive summary.....	1
Key findings.....	1
Introduction.....	3
CTE programs in Virginia.....	4
Research approach and data sources.....	5
Research Approach.....	5
Data sources.....	9
Data from graduates’ high school experiences.....	9
Data from high school graduates’ postsecondary enrollment, persistence, and completion.....	10
Study results.....	11
What were the characteristics of CTE completers and non-completers who graduated from high school?.....	11
What were the postsecondary enrollment outcomes for CTE completers?.....	13
What were the postsecondary persistence rates for CTE completers?.....	15
What were the postsecondary completion outcomes for CTE completers?.....	17
What other high school factors were associated with graduates postsecondary enrollment, persistence, and completion?.....	20
Summary and recommendations.....	21
The importance of high school course-taking.....	22
Recommendations.....	23
Works Cited.....	26
Appendix A. Multinomial logistic regression methods and results.....	29
Results of the multinomial regression models.....	31

Table of Figures

Figure 1. Conceptual model of CTE postsecondary and workforce outcomes.....	9
Figure 2. Percent of CTE completers in Virginia's 2008 and 2009 graduating cohorts	12
Figure 3. Percent of CTE completers and non-completers who enrolled in college within one year of high school graduation	14
Figure 4. Percentage of college-enrolled high school graduates, by college type and CTE completion status	14
Figure 5. Percentage of high school graduates who enrolled in college by CTE completer status, high school diploma type, and first-year college enrollment type, 2008 high school graduates.	15
Figure 6. Persistence into college years 2, 3, and 4 by college type, college-enrolled graduates from the 2008 high school cohort	16
Figure 7. Persistence rates, college-enrolled 2008 high school graduates, by CTE completer status, diploma type, and college type.....	17
Figure 8. Percentage of high school graduates who earned college credentials within five years of high school graduation	18
Figure 9. Percentage of high school graduates who earned college credentials within five years, by CTE completer status and high school diploma type.....	19
Figure 10. Percentage of college-enrolled high school graduates college enrollment within one-year of high school graduation by CTE completer status and high school diploma type	20

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Executive summary

In Virginia, nearly half of all high school graduates—more than 40,000 graduates per year—complete a career and technical education (CTE) program of study. Virginia’s CTE instructional programs are designed to prepare young people for productive futures while meeting the Virginia’s need for well-trained and industry-certified technical workers. They aim to integrate instruction to ensure that students graduate meeting academic standards along with workplace readiness and industry-specific technical skills. CTE programs prepare students for postsecondary education, training, and for beginning careers. Programs vary in content, but include a sequence of at least two courses in a career pathway as part of graduation requirements.

Leadership in the Virginia Department of Education’s (VDOE’s) Office of Career and Technical Education (CTE) regularly works with Virginia’s local educators to strengthen program quality, with the goal of ensuring that all CTE graduates are prepared for success in college and careers. As part of federal reporting requirements, VDOE’s CTE office prepares annual reports on the 9-month college- and employment status of students who complete a CTE program of study (i.e., CTE completers). CTE leaders need more information about completers’ long-term college and employment outcomes. Based on data available by using the Virginia Longitudinal Data System (VLDS), this report is one of two prepared as part of a research project that followed CTE completers from high school graduates in the 2008 and 2009 cohorts through the fall of 2013. This report focuses on three postsecondary outcomes:

1. College enrollment within one year of high school graduation
2. Persistence of college-enrolled high school graduates
3. College completion rates

Using VLDS, our research team accessed college enrollment, persistence, and completion data from in-state and out-of-state colleges and universities in the United States collected from the State Council of Higher Education for Virginia and the National Student Clearinghouse. Combined, these two data sources capture the vast majority of college enrollments and 2- and 4-year college degrees for Virginia’s high school graduates. These sources, while the best currently available, do not capture all one-year credentials (e.g., technical and professional licenses) that high school graduates may earn during or after a postsecondary education or training experience.

Key findings

Out of the 2008 sample of 77,006 and 2009 sample of 82,105 high school graduates, approximately 45 percent were CTE completers. On average, CTE completers had lower high school achievement and were more likely to be economically disadvantaged, African American,

and male compared to non-completers. The following summarizes study findings for college enrollment, persistence, and completion.

- In each graduating class approximately 66 percent of CTE completers and 73 percent of non-completers enrolled in college within one-year of high school graduation.
- On average, CTE completers were less likely to enroll in 4-year colleges and more likely to enroll in 2-year colleges compared to non-completers.
- By the end of the 5-year study period, approximately 57 percent of CTE completers and 64 percent of non-completers from the high school graduates of 2008 had earned college credentials. College-enrolled CTE completers were more likely to earn Associate’s degrees and equally likely to earn Bachelor’s degrees compared to non-completers.
- While college-enrolled CTE completers had similar chances of earning a Bachelor’s degree compared to non-completers, CTE completers earned a smaller proportion of these 4-year degrees because they were less likely to enroll in 4-year colleges.

Perhaps the most striking difference that we observed throughout the study was the large benefit that high school graduates who earned Advanced Studies diplomas—CTE completers and non-completers alike—have in enrolling, persisting, and completing college compared to graduates who earned Standard diplomas.

Our research demonstrated the value of high school students participating in a college-preparatory course of study, represented by their completion of an Advanced Studies diploma. The odds of Advanced Studies diploma-earners enrolling in 4-year colleges was approximately 6 times that of Standard diploma earners; the odds of Advanced Studies diploma-earners enrolling in 2-year colleges was 1.8 times that of Standard diploma-earners. Once enrolled, Advanced Studies diploma earners had more than 2 times the odds of persisting or earning a college credential within 4-years compared to Standard diploma-earners. Among the college-enrolled high school graduates, the odds of earning a Bachelor’s degree was more than 4 times higher for Advanced Studies diploma earners compared to Standard diploma earners, and Advanced Studies diploma-earners had better odds of earning Associate’s degrees as well. These findings applied to CTE completers and non-completers.

For CTE programs, these findings emphasize the critical importance of ensuring that CTE program participants have access to, participate in, and successfully master the academic content embedded in Virginia’s Advanced Studies diploma requirements. To ensure access and success, CTE experts throughout the country recommending integrating this content into courses that also include instruction aimed at building students workplace and technical skills.

Introduction

In Virginia, almost half of public school high school graduates—more than 40,000 graduates per year—complete a career and technical education (CTE) program of study. Virginia’s CTE instructional programs are designed to prepare young people for productive futures while meeting the Virginia’s need for well-trained and industry-certified technical workers. Programs are designed to integrate instruction that ensures that students graduate meeting rigorous academic standards, and have workplace readiness and industry-specific technical skills. CTE programs prepare students for postsecondary education, training, and for beginning careers. Each program of study varies in content, but all include a sequence of at least two courses in a career pathway¹ as part of graduation requirements.

CTE programs offer high school students multiple academic pathways and opportunities (Barnett & Bragg, 2006), and have a history of helping students gain valuable knowledge, skills, abilities, and dispositions that prepare them for careers (Bishop & Mane, 2003) while providing academic, technical, and workplace content in applied settings (Shumer, Stringfield, Stipanovic, & Murphy, 2011). Historically, the goal of CTE has been for all students to finish high school prepared either to enter the workplace *or* to be prepared for postsecondary education (Castellano, Stringfield, & Stone, 2003). However, demand for more highly skilled and educated workers has increased in recent decades, and the trend is expected to continue. For example, experts estimate that by 2018, 63 percent of all new jobs in the United States and 64 percent in Virginia will require at least some postsecondary education and training, and that employers nationally will need 22 million new workers with postsecondary degrees (Carnevale, Smith, & Strohl, 2010). Further, at current rates of degree attainment, projections suggest that there will not be enough college graduates to meet that need (Carnevale, et al., 2010).

Throughout the country, CTE programs are critical components of states’ broader efforts to prepare more high school graduates for success in diverse types of postsecondary education and training programs. As such, CTE programs of study are increasingly integrating rigorous academic content with workplace and technical skills as a key strategy for strengthening high school graduates preparation for college and careers. This combination is considered best practice among leading policy makers (Association for Career and Technical Education, 2010; Career Readiness Partner Council, 2012), and has been shown to increase student attachment to and motivation in school among 9th graders who are 14 years of age or younger (Plank, DeLuca, & Estacion, 2008). CTE program participation is also associated with higher rates of

¹ Each career pathway represents a common set of skills and knowledge, both academic and technical, necessary to pursue a full range of career opportunities within that pathway—opportunities ranging from entry level to management, including technical and professional career specialties. Career pathways are nested within 16 broad career clusters. For more information, visit [VDOE’s website](#).

high school attendance and graduation (Bishop & Mane, 2004; Carnevale, Rose, & Hanson, 2012; Dare, 2006), including for students with disabilities (Shandra & Hogan, 2008).

Evidence is mixed on whether participating in CTE programs of study promote increased access to and success in postsecondary education programs. While some studies show that on average, high school graduates who complete a CTE program of study are more likely to enroll in and graduate from college than similar graduates who were not CTE completers (Bishop and Mane 2004; Dare 2006; Carnevale, Rose and Hanson 2012), others suggest that CTE has limited influence after controlling for students high school coursetaking (DeLuca, Plank, & Estacion, 2006).

CTE programs in Virginia

In Virginia, high schools are required to implement “competency-based career and technical education programs that integrate academic outcomes, career guidance, and job-seeking skills for all secondary students.”² Within this context, and requirements associated with federal funding under the Perkins Act, schools have options to offer diverse CTE programs of study that align with student interests and local labor needs. CTE programs of study fall within 16 Career Clusters that were developed to “help students investigate careers and design their courses of study to advanced their career goals” (Virginia Department of Education, 2014). CTE programs are diverse, and prepare students for careers in fields such as health sciences; agriculture, food and natural resources; arts, audio/video technology, and communications; finance; information technology; hospitality and tourism; and more. High school graduates are considered “CTE Completers” after meeting Virginia’s high school graduation requirements³ and have completing a series of two or more CTE courses in a defined sequence.

VDOE’s CTE leaders are interested in using data and conducting research to better understand the influence of CTE completion on graduates’ success when they leave high school—in college, employment, and in the military. Using data available via [VLDS](#) (Virginia Longitudinal Data System), this report describes postsecondary enrollment, persistence, and completion after high school graduation for the Virginia public school graduating cohorts of 2008 and 2009. It is one of two reports prepared as part of a broader research project assessing postsecondary and employment outcomes several years after high school graduation (see [Yamaguchi, Garland, & Jonas, 2014](#)).

² From Virginia Standards of Quality, 2014, http://www.doe.virginia.gov/administrators/superintendents_memos/2014/183-14a.pdf.

³ See <http://www.doe.virginia.gov/instruction/graduation/index.shtml>.

Research approach and data sources

This report describes outcomes for CTE completers compared to non-completers from the public high school graduating cohorts of 2008 and 2009. We focused on answering the following research questions:

- 1) What are the characteristics of CTE completers and non-completers who graduate from high school?
- 2) What were the postsecondary enrollment outcomes for CTE completers?
- 3) What were the postsecondary persistence rates for CTE completers?
- 4) What other high school factors were associated with graduates postsecondary enrollment, persistence, and completion?

We answered these questions using data made available through [VLDS](#). VLDS is a system that includes technology, people, policy, and governance. This system allows authorized users to access data from multiple state agencies after it has gone through a complex double de-identification process to ensure that individuals' private, personal information are not provided to research teams. Our research team, with sponsorship from VDOE, was authorized to access high school, college, and wage records from VDOE, State Council of Higher Education for Virginia (SCHEV), and the Virginia Employment Commission (VEC) records. This report used data from VDOE and SCHEV only (see [Yamaguchi, et al., 2014](#) for the corresponding report that used employment records).

Research Approach

In answering the research questions, we set out to describe high school graduates' postsecondary enrollment within one-year of high school graduation; assess whether college-enrolled high school graduates remained in college, or persisted over time; and, whether they earned a college credential. Using VLDS, we were able to calculate college enrollment in graduates' first year after high school; persistence in college through 2012; and degree completion by fall 2013. This provided up to 4-years of college persistence data, and up to 5-years of completion data for 2008 high school graduates.

We were also interested in understanding postsecondary outcome patterns for two other factors: enrollment in 2- year versus 4-year colleges; and, whether high school diploma type influenced postsecondary outcomes. Our interest in patterns of enrollment into 2- and 4-year colleges stemmed from the nature of CTE programs themselves. Many of Virginia's high school CTE programs have articulation agreements with Virginia's Community Colleges. While the specifics of agreements at each high school vary, these types of agreements often enable students to participate in college-level courses while in high school; help to ensure that high school course content, learning experiences, and expectations align with the next steps in

education and training programs available in community colleges; and increase the chances that high school graduates can experience seamless transitions from high school to college. As such, it is possible that CTE completers' enrollment patterns differ from those of non-completers.

Our interest in understanding how high school diploma type influenced postsecondary outcomes stems from national research demonstrating the critical role of high school courses in predicting postsecondary outcomes ([Adelman, 2006](#)) and our previous research assessing postsecondary outcomes for Virginia high school graduates. The minimum course requirements in Virginia's Advanced Studies diploma are aligned with courses that research suggests are critical for college enrollment and success (Adelman, 2006). Also, previous research in Virginia has shown that high school graduates' diploma type is a strong predictor of students' college enrollment; enrollment directly in credit bearing college courses ([Garland. et al., 2011](#)); success in college-level credit-bearing courses ([Jonas, et al., 2012](#)); and four-year college persistence and completion ([Jonas & Garland, 2014](#)). This research has also shown that the Standard diploma is associated with lower rates of postsecondary enrollment, persistence, and completion relative to the Advanced Studies diploma. As such, we relied on the diploma type as a categorical proxy measure for the rigor of the courses students took in high school (Exhibit 1 for more information about minimum requirements students needed to meet to earn Standard and Advanced Studies diplomas).

Exhibit 1. Description of minimum requirements for students to earn Virginia's Standard and Advanced Studies diplomas

Virginia has two [diplomas](#) that are federally recognized and available to all high school students, the Standard and Advanced Studies diploma. Students in this study who earned both diploma types were required to complete four years of high school English. Requirements for other core content areas varied by diploma type. The table below shows the minimum core course requirements for the 2008 cohort graduates earning each diploma type.⁴ The Advanced Studies diploma is aligned with the minimum course of study that students need to succeed in a four-year college program (Adelman, 2006). Students earning Virginia's Advanced Studies diplomas were required to complete a course of study that included four years of content in each core content area and three years of foreign language. Students were required to complete mathematics courses that included Algebra II or higher, and science courses including chemistry or physics. Virginia's 2008 and 2009 graduates who earned Standard diplomas were not required to participate in Algebra II, chemistry or physics, nor were they required to participate in foreign language courses.

Major components of diploma requirements for Virginia's high school graduates of 2008

Diploma type	Core Course Requirements	Minimum high school credits required
Advanced Studies diploma	English	4
	Mathematics*	4
	Lab Science	4
	History and Social Sciences	4
	Foreign Languages	3
Standard diploma	English	4
	Mathematics**	3
	Lab Science	3
	History and Social Sciences	3
	Foreign Languages	0

* All courses were required to be at or above the level of algebra and include at least three different course selections from among: Algebra I, Geometry, Algebra II, or other mathematics courses above the level of Algebra II.

**All courses were required to be at or above the level of Algebra and include at least two course selections from the following list: Algebra I, Geometry, Algebra II, or other mathematics courses above the level of algebra and geometry.

Throughout our research, we aimed to provide Virginia's CTE leaders with information describing the outcomes of CTE completers. We also calculated the enrollment, persistence, and completion rates for high school graduates who were not CTE completers (or non-completers), to serve as a comparison group. To provide this information, we calculated simple descriptive statistics (i.e., numbers and percentages) for CTE completers and non-completers who met each postsecondary outcome.

While the comparison between CTE completers and non-completers is informative, this direct comparison does not take into account differences other than CTE completion status. To

⁴ Complete course requirements for each diploma may be found by visiting, <http://www.doe.virginia.gov/instruction/graduation/index.shtml>. The information available includes changes in graduation requirements that went into effect for first-time ninth graders entering high school in 2011/12 or later.

account for other differences in these populations, we used multivariate regression⁵ models to interpret whether descriptive differences between outcomes for CTE completers and non-completers were meaningful. The regression models enabled us to more closely approximate “apples-to-apples” comparisons between CTE completers and non-completers. In each model, we selected specific estimation procedures based on the measurement of the outcome of interest. All models statistically controlled for student demographic characteristics and program participation in high school, high school achievement, and school-level characteristics using measures available within VLDS.

We developed the multivariate models based on the conceptual model of postsecondary and workforce outcomes shown in Figure 1. In this study, we focused on postsecondary outcomes, represented in Figure 1 by the green boxes. We controlled for student-level and school level experiences, which are shown in blue in the figure. Items shown in gray were not included in this study, but were included in statistical models used in Yamaguchi et al. (2014), which used the same data to assess CTE completers’ workforce outcomes.

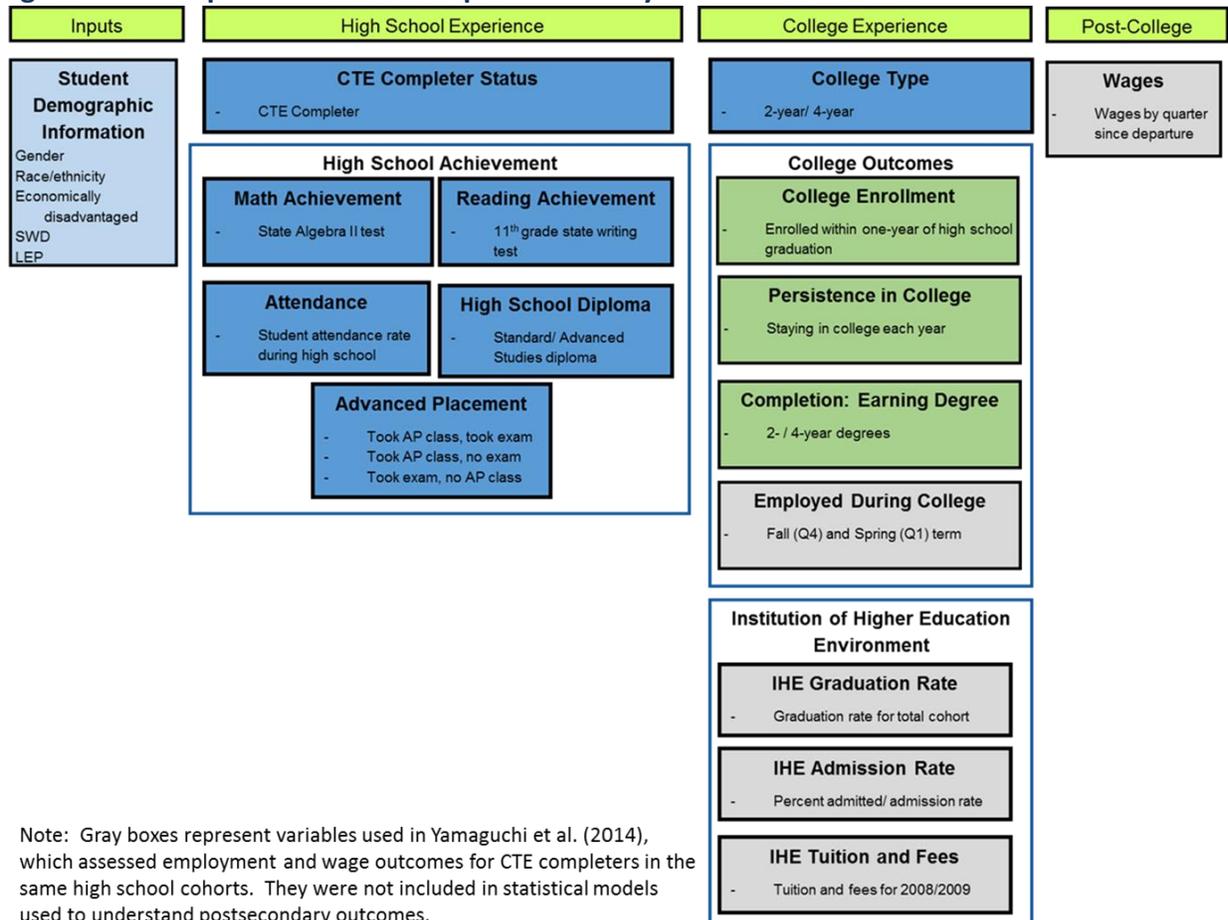
Student factors included in the statistical models were demographic information, high school achievement, and attendance. Statistical controls for high school characteristics were created by taking the average school achievement on state Algebra II and 11th grade writing tests⁶, and diploma type; school population characteristics; and average attendance rates. We modeled outcomes separately for 2- and 4-year colleges.⁷ To model college enrollment, we estimated the influence of CTE completion and other factors on the full population of high school graduates. We estimated separate models for the class of 2008 and 2009. To model persistence and completion, we limited the sample population to college-enrolled students. Complete results from the multivariate models are shown in [Appendix A](#).

⁵ Multivariate analysis refers to statistical models that have 2 or more dependent (or outcome) variables. Multivariate regression includes one or more independent (or predictor) variables and 2 or more dependent (or outcome) variables. The statistical models used in this study included multiple independent variables and multiple, categorical dependent variables.

⁶ We chose to use the writing test and not the reading test based on previous research showing that Virginia’s 11th grade writing test was a stronger predictor of college outcomes than reading (Garland, et al., 2011). From that research, it was not clear whether this finding was related to the content—writing itself—or greater variability in the writing test scores relative to the reading scores.

⁷ Due to the small number of students who enrolled in less than 2-year programs, these students were included in the models for 2-year college enrollment, persistence, and completion.

Figure 1. Conceptual model of CTE postsecondary and workforce outcomes



Data sources

With authorization from VDOE and SCHEV, we used VLDS to request and receive de-identified, individual records for students in the high school graduating cohorts of 2008 and 2009. We accessed high school records from VDOE’s state administrative data, and postsecondary records from SCHEV and the National Student Clearinghouse (NSC) records that VDOE maintains. Based on VLDS secure methods, we were able to link records from individuals in the data using a randomly generated identifier unique to the data we requested. All personal information (e.g., names, social security and other identification numbers, date of birth) were stripped from the data before they were securely transferred to the research team.

Data from graduates’ high school experiences

High school records included data for the Virginia On-Time Graduation Rate cohorts of 2008 and 2009. Records included student demographic characteristics (e.g., race/ethnicity, economically disadvantaged status); program participation (e.g., support services for students with disabilities and English learners); high school achievement based on scores from the Virginia Algebra II and 11th grade writing tests; and high school diploma type.

Data from high school graduates' postsecondary enrollment, persistence, and completion

Using VLDS, we obtained data for high school graduates' postsecondary enrollment, persistence, and degree completion from SCHEV and NSC. We combined the two sources of postsecondary data to obtain the most complete, unduplicated data set available on Virginia's high school graduates who enroll in college nationwide (see Appendix B, [Jonas, 2014](#), for more information on the value of the combined data sets). Data from SCHEV were available through the spring semester, 2012; data from NSC were available through fall 2013. Due to the longitudinal nature of the persistence measure, and the importance of combining the two data sets for this measure, persistence calculations ended in the spring of 2012, which follows the 2008 high school graduates for four years. Our college credential calculations were based on earning a credential any time for which we had data, and are not dependent on longitudinal, year-on-year linkages in the data. As such, we reported outcomes for 2008 high school graduates who earned credentials using all of the data available at the time, which was for up to 5 years after high school graduation.

Data from both SCHEV and NSC included the college in which the student was enrolled, college type (4-year, 2-year, less than 2-year), enrollment dates and timing, and credentials earned. We used this information to create the following outcome variables used in the project:

- **College enrollment:** identifies students who enrolled in college within one-year of high school graduation, excluding summer enrollments.
- **College persistence:** identifies students who remained college-enrolled in each subsequent school year, or, who had earned a credential in a prior semester. Including students who earned a credential as part of our persistence definition ensures that the results do not inadvertently penalize students who earned a credential and left college. For example, students who earned a 1-year certificate in their first year of college are counted as having persisted in all four years.
- **College completion:** identifies students who earned 1-, 2-, and 4-year college credentials by fall 2013.⁸ This enabled us to document credentials earned for up to 5 years for the 2008 graduates and up to 4 years for the 2009 graduates. We note here

⁸ One year programs typically provide students an opportunity for focused study in a specific subject, most often a vocational topic, while 2- and 4-year degree programs offer broader (at the undergraduate level) and more advanced platforms of study. It is important to note that this data set, which includes records from SCHEV and NSC, may not include all certificates awarded to high school graduates, but, is currently the most complete data available for Virginia high school graduates. More information about how Virginia defines college completion is available by reviewing SCHEV's [Guide to the Degrees Awarded Reports](#). For an overview of challenges related to one-year certificates and other non-degree credentials, see the report entitled, [Creating a Competency-Based Credentialing Ecosystem](#) (2014) published by the Center for Law and Social Policy (CLASP).

that data from the 2012/13 school year were limited to credentials that were documented in the NSC data—SCHEV data were only available through spring 2012.

- **College-type:** identifies students as enrolled in 2- or 4-year colleges based on each student’s last enrollment during the first year after high school. For example, students who enrolled in 2-year colleges in the first fall after high school graduation, and then enrolled in a 4-year college in the spring of the same school year (e.g., 2008/2009) were categorized as being enrolled in 4-year colleges under for this measure. Throughout the enrollment and persistence calculations, we reported outcomes based on the college type of high school graduates’ first year of college, regardless of students’ transfer status in later years. For example, 2008 high school graduates who enrolled in 2-year colleges for the 2008/09 school year and transferred to a 4-year college in 2009/10 were categorized as 2-year college students in all of the enrollment and persistence calculations. College completion data capture all degree types, regardless of the type of college in which a student enrolled in the first year after high school graduation.

Study results

Throughout the report, we display descriptive statistics (numbers and percentages) of CTE completers and non-completers who met the enrollment, persistence, and completion outcomes. We present the results using graphs that show CTE completers in purple and non-completers in blue. We then use the results of the regression models to help investigate whether observed differences in the descriptive outcomes were associated with CTE program participation after adjusting for other differences between CTE and non-CTE completers.

What were the characteristics of CTE completers and non-completers who graduated from high school?

CTE completers comprised just under half of all high school graduates in the 2008 and 2009 cohorts (see Figure 2). The 43.5 percent of CTE completers in 2008 represents 33,464 high school graduates, and in 2009, the number increased to 37,544.

Figure 2. Percent of CTE completers in Virginia's 2008 and 2009 graduating cohorts

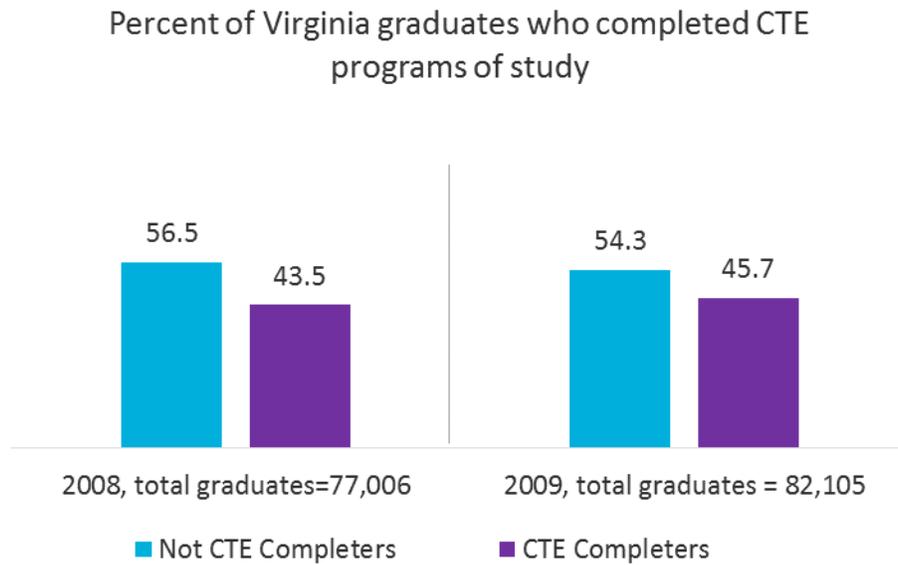


Table 1 displays the high school achievement and demographic characteristics of high school graduates who were not completers and those who were CTE completers in the 2008 and 2009 graduating cohorts. On average, CTE completers had different demographic and high school achievement characteristics. Compared to non-completers, CTE completers had lower high school achievement and were less likely to participate in a college preparatory course of study, as represented by a smaller percentage of CTE completers earning an Advanced Studies diploma. Compared to non-completers, a smaller percentage of CTE completers participated in Advanced Placement courses in high school, and a smaller percentage of CTE completers participated in Algebra II (which is required to earn an Advanced Studies diploma). When they participated in the Algebra II test, on average, CTE completers earned lower scores than non-completers. As well, CTE completers had lower average scores on the 11th grade state writing test.

In addition to demonstrating lower achievement on average, CTE completers were more likely to be economically disadvantaged, African American, and male. Previous research has shown that African Americans are more likely to participate in career-related high school programs (DeLuca, Plank, & Estacion, 2006).

Table 1. Demographic and achievement characteristics of CTE completers and non-completers

Descriptive indicator	2008 cohort		2009 cohort	
	Not CTE	CTE	Not CTE	CTE
	Completers N = 43,542	Completers N = 33,464	Completers N = 44,561	Completers N = 37,544
Student achievement variables				
Earned Standard diplomas (%)	37	50	37	50
Earned Advanced Studies diplomas (%)	60	46	58	46
Algebra II scaled score (mean)	509	505	511	507
Algebra II participation (%)	84	81	88	85
Writing scaled score (mean)	523	509	529	515
Attendance rate	94	94	94	94
Advanced Placement course participation (%)	40	23	40	23
Demographic variables				
Asian (%)	6	5	7	5
African American (%)	21	27	22	28
Hispanic (%)	6	5	6	6
White (%)	65	62	63	60
Economically disadvantaged (%)	16	22	18	25
Male (%)	46	52	46	53

What were the postsecondary enrollment outcomes for CTE completers?

Approximately 70 percent of Virginia’s high school graduates in 2008 enrolled in college within one year of high school graduation (see also [Jonas & Garland, 2014](#)). Reviewing college enrollment rates by CTE completer status (see Figure 3), reveals that a larger percentage of non-completers enrolled in college within one year of high school graduation than CTE completers. In the 2008 and 2009 high school graduating classes, approximately 77 percent of non-completers and 66 percent of CTE completers enrolled in college within one-year of high school graduation.

Figure 3. Percent of CTE completers and non-completers who enrolled in college within one year of high school graduation

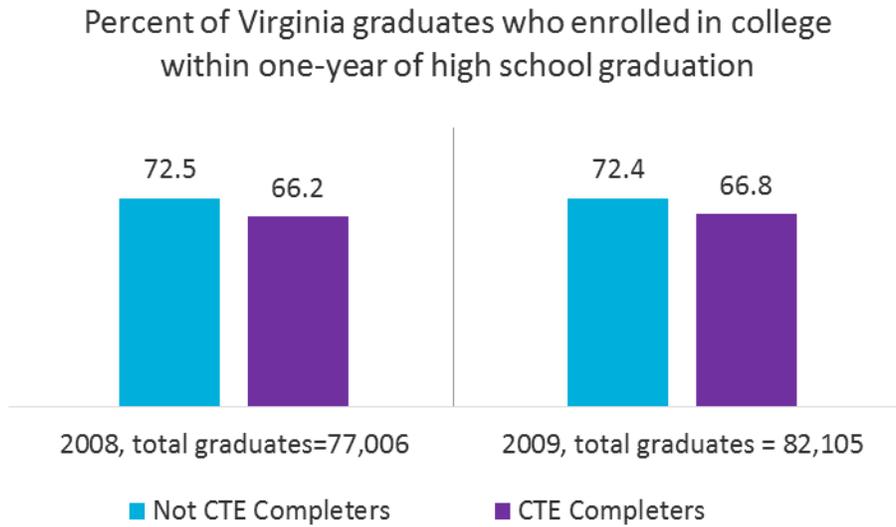
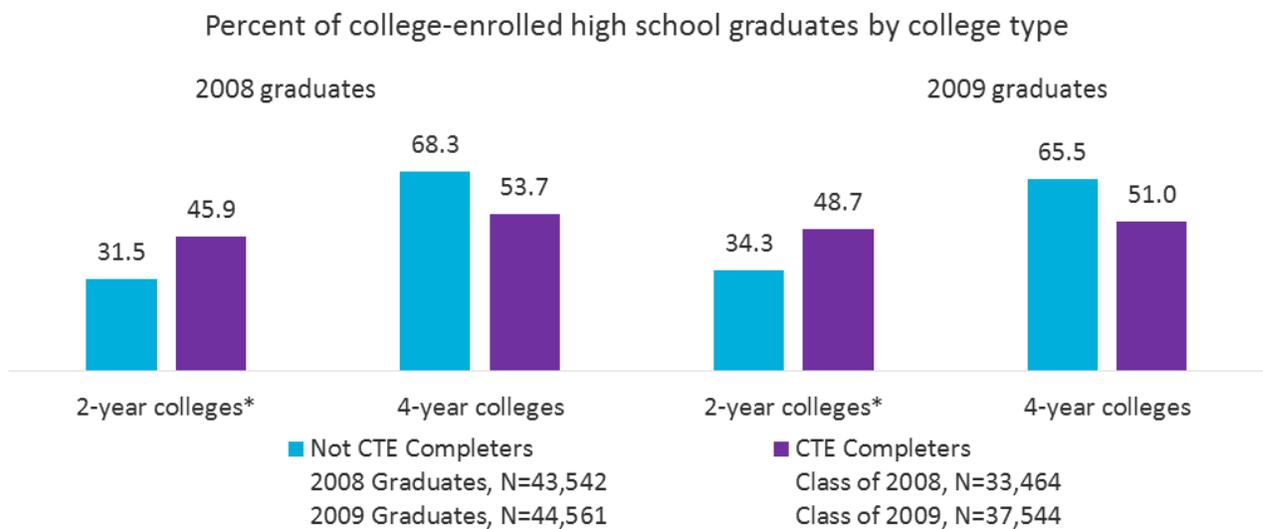


Figure 4 displays the distribution of college-enrolled graduates by CTE completion status and the type of college in which they enrolled in the first year after high school. Results show that compared to non-completers, a larger percentage of college-enrolled CTE completers initially enrolled in 2-year colleges and a smaller percentage of CTE completers enrolled in 4-year colleges.

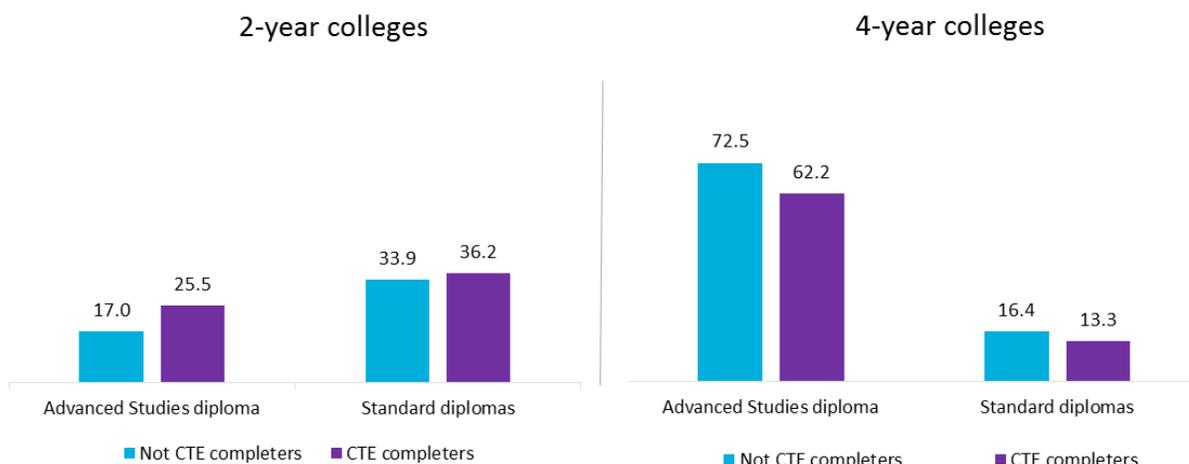
Figure 4. Percentage of college-enrolled high school graduates, by college type and CTE completion status



*Includes enrollments in 1-year postsecondary programs for which data were available.

Figure 5 shows the percentage of 2008 high school graduates who enrolled in college within one-year of high school graduation by CTE completer status, high school diploma type, and first-year college enrollment type.⁹ The differences between non-completers' and CTE completers' college enrollment rates were reduced when we took high school diploma type into consideration. Results of the regression calculation showed that the differences between non-completers' and CTE completers' enrollment in two-year colleges were minimal and not practically significant after adjusting for student achievement outcomes, student demographics, and school-level experiences. However, even after statistically adjusting for these student and school characteristics, *the odds of CTE completers enrolling in 4-year colleges was 15 percent lower than the odds of non-completers enrolling*, and the finding was consistent for the 2008 and 2009 cohorts.

Figure 5. Percentage of high school graduates who enrolled in college by CTE completer status, high school diploma type, and first-year college enrollment type, 2008 high school graduates.



Even after adjusting for high school graduates' prior achievement, demographic characteristics, and school experiences, CTE completers were less likely to enroll in 4-year colleges compared to non-completers.

What were the postsecondary persistence rates for CTE completers?

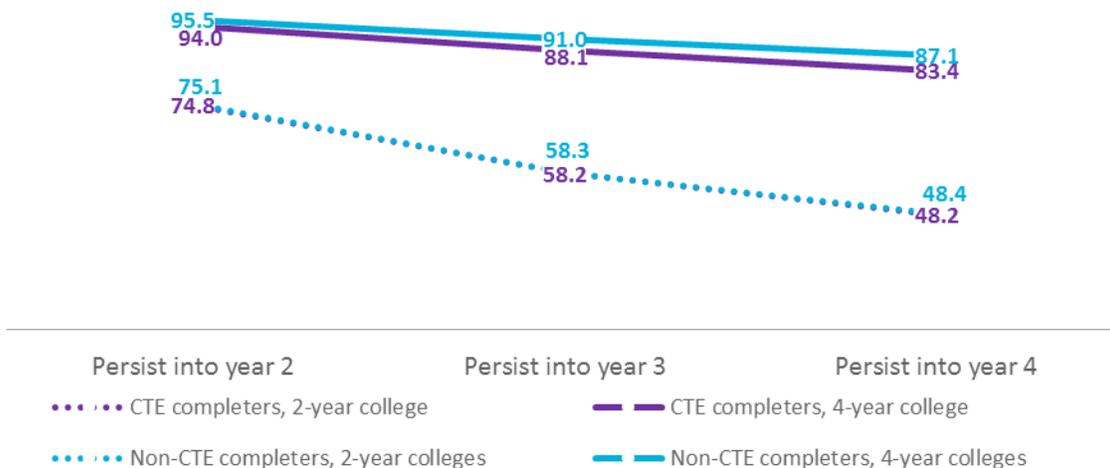
Postsecondary persistence is critical for college students to earn their degrees—if they're not in school, students can not earn a college credential. Figure 6 shows persistence rates for students who were college-enrolled within one-year of high school graduation for non-completers and CTE completers in 2- and 4-year colleges. These results suggest there were no

⁹ For simplicity, we limited the data display to the 2008 high school graduates, although the findings were similar for 2009 graduates.

differences in persistence rates based on CTE completion status, and this was confirmed by the non-significant results of the regression models estimated for persistence in 2- and 4-year colleges.

Once high school graduates were enrolled in college, CTE completion status was not associated with their likelihood of staying in college for up to four years. This was true for students enrolled in 2- and 4-year colleges.

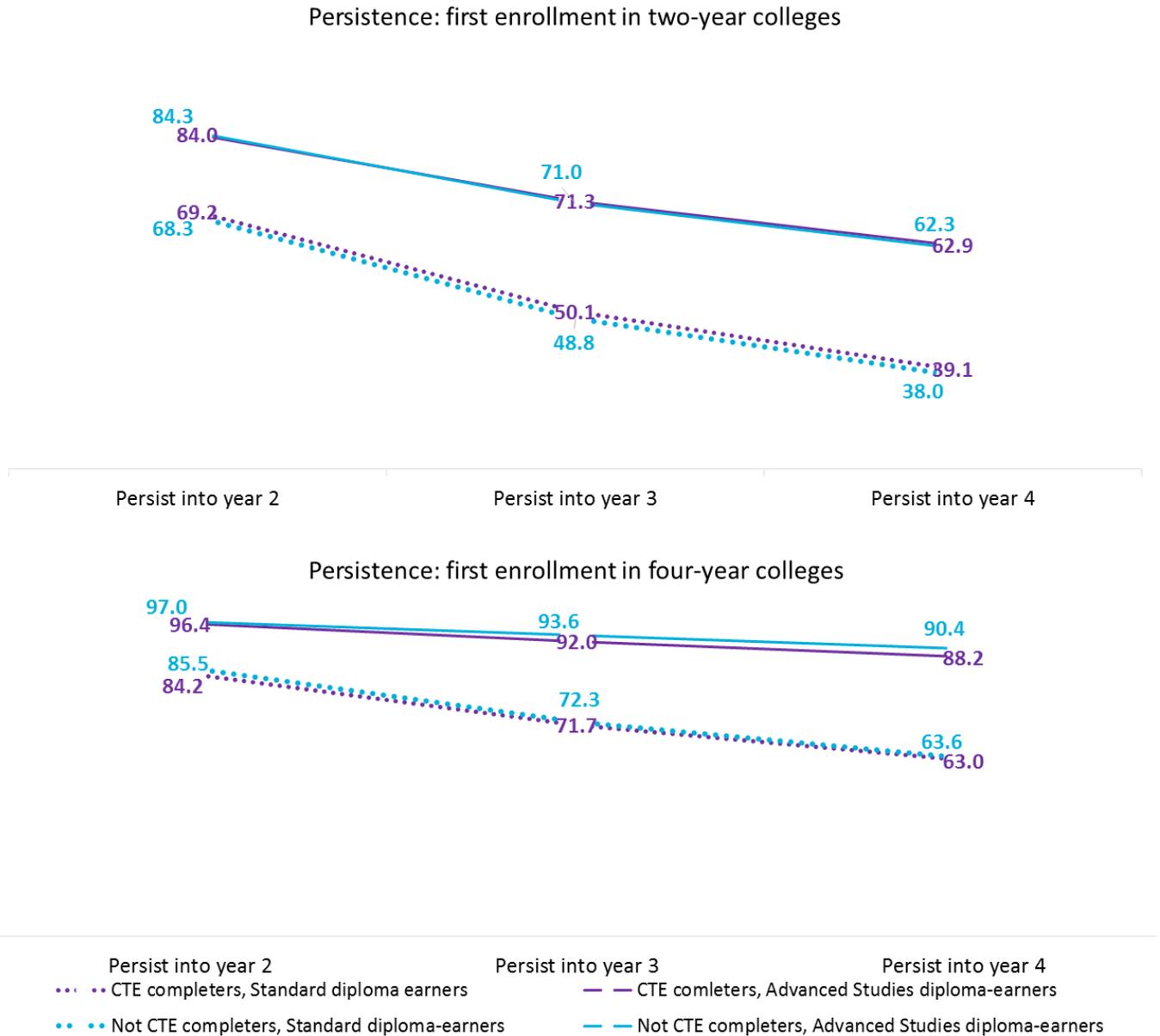
Figure 6. Persistence into college years 2, 3, and 4 by college type, college-enrolled graduates from the 2008 high school cohort



While CTE completer status did not influence persistence rates, the high school diploma type and college type did influence persistence rates for those who were college enrolled. Figure 7 shows persistence rates for college-enrolled high school graduates from 2008 who initially enrolled in 2- and 4-year colleges by diploma type and CTE completer status. Persistence rates were nearly identical for CTE completers and non-completers, regardless of diploma or college type. Furthermore, students who graduated with Advanced Studies diplomas had higher average persistence rates whether they initially enrolled in 2- or 4-year colleges. In general, however, high school graduates who initially enrolled in 2-year colleges, on average, had lower persistence rates than high school graduates who initially enrolled in 4-year colleges, and this was true for graduates who earned Advanced Studies and Standard diplomas.¹⁰

¹⁰ This is true even though our definition of persistence *includes* students who earned a credential in college in any prior year. Thus, students who earned a 1- or 2-year credential were shown as having positive outcomes in all later years (see our operational [definition of persistence](#) for more information).

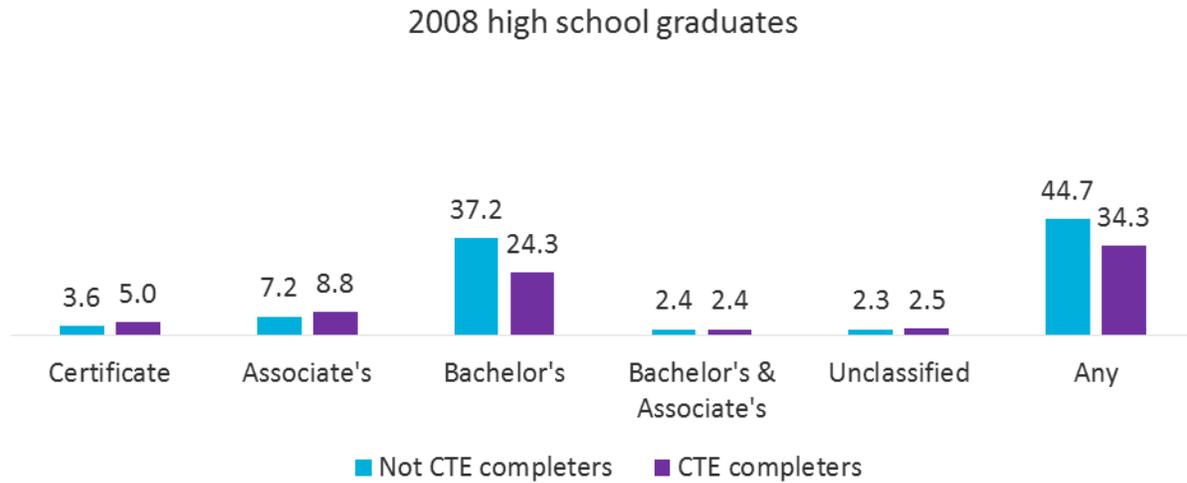
Figure 7. Persistence rates, college-enrolled 2008 high school graduates, by CTE completer status, diploma type, and college type



What were the postsecondary completion outcomes for CTE completers?

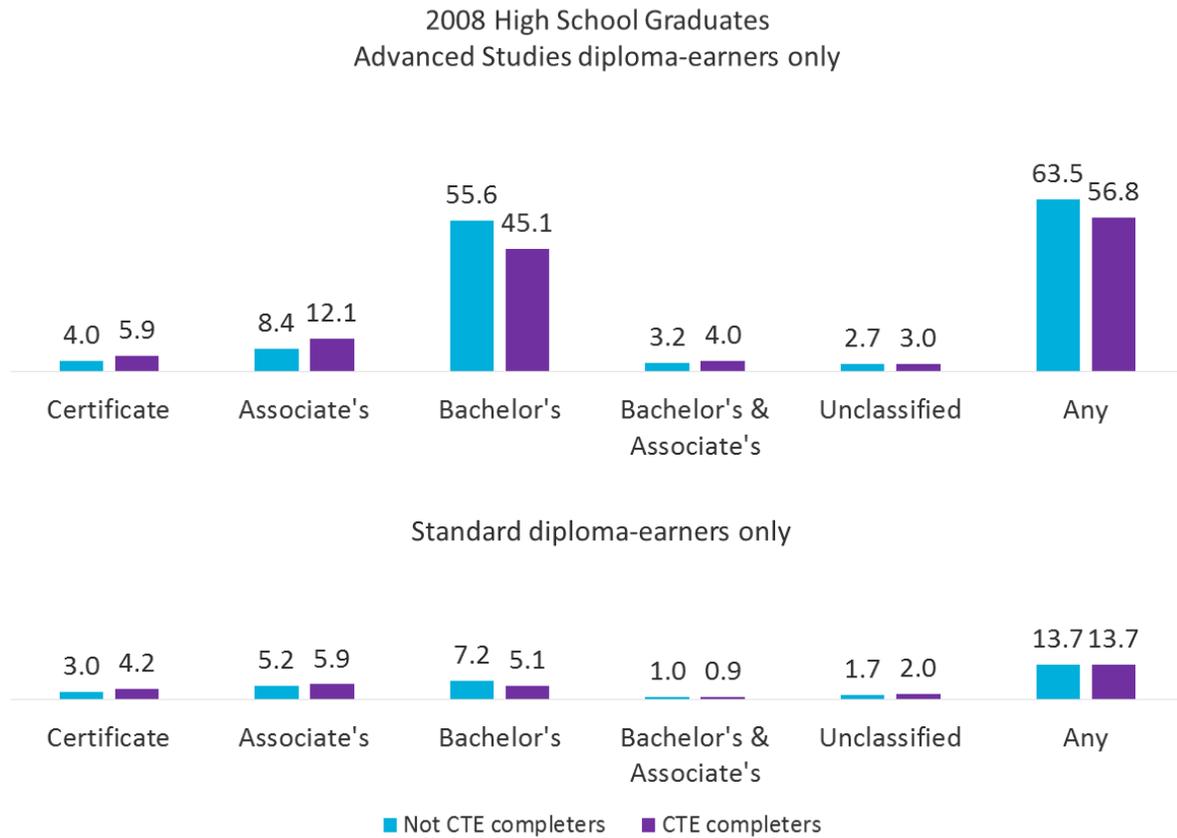
Within five years of high school graduation, in the class of 2008, 40 percent of graduates had earned a college credential. As represented by the bars in Figure 8 showing the percentage of non-completers and CTE completers who earned “Any” college credential, a larger percentage of non-completers earned credentials (44.7) compared to CTE completers (34.3). The data in Figure 8 also show that a compared to non-completers, a larger percentage of CTE completers earned Associate’s degrees, although a smaller percentage earned Bachelor’s degrees.

Figure 8. Percentage of high school graduates who earned college credentials within five years of high school graduation



As was the case with postsecondary enrollment and persistence, whether or not high school graduates participated in a college preparatory course of study, represented by the Advanced Studies diploma, had the largest relative influence on whether or not high school graduates earned a college credential. Figure 9 shows the percentage of the 2008 high school graduates who earned college credentials by CTE status and high school diploma type. Approximately 64 percent of non-completers who had earned Advanced Studies diplomas in high school had earned a college credential within 5 years of high school graduation, and 57 percent (56.8) of CTE completers who earned Advanced Studies diplomas earned a college credential within 5 years. For non-completers and CTE completers who earned Standard diplomas, just under 14 percent (13.7) earned college credentials within 5 years.

Figure 9. Percentage of high school graduates who earned college credentials within five years, by CTE completer status and high school diploma type



Results of the multivariate analysis confirmed that even after controlling for student demographic and achievement characteristics, and high school experiences, CTE completers who enrolled in college had a 1.21 times greater chance of earning Associate’s degrees and certificates than non-completers.

The influence of CTE completer status on high school graduates’ odds of earning a 4-year degree, however, is more complicated. The regression suggests that the differences in 4-year outcomes apparent in the descriptive statistics are largely related to a) CTE completers having a lower likelihood of enrolling in 4-year colleges in general, and b) differences in the population and achievement characteristics between the two populations.

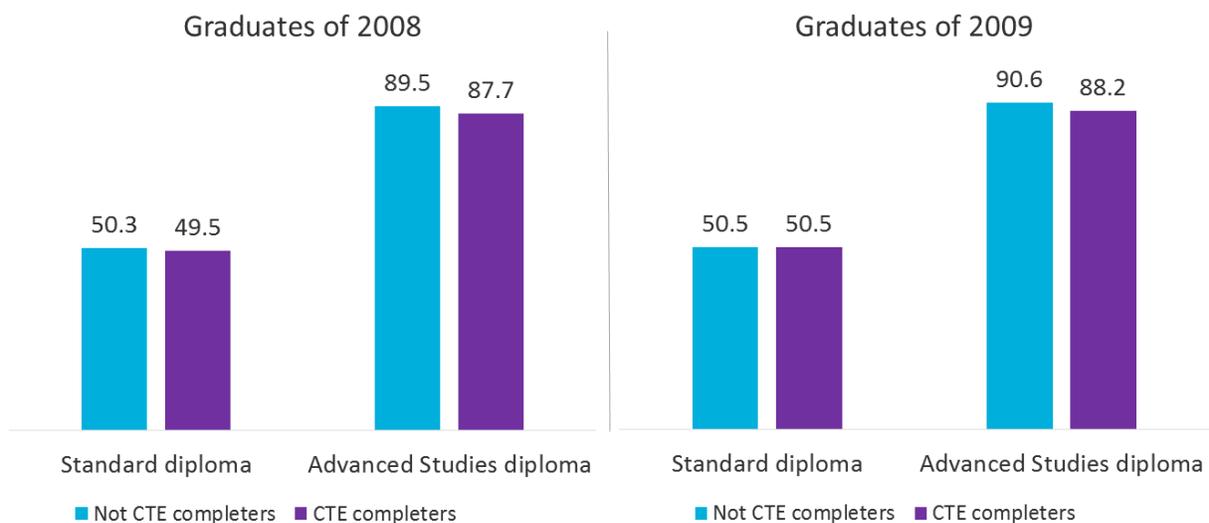
Once enrolled in college, CTE completers and non-completers have the same likelihood of earning a 4-year degree within 5 years. However, because CTE completers are less likely to enroll in 4-year colleges, these high school graduates have an overall lower chance of earning a 4-year degree.

Specifically, the regression results suggest that once they are college-enrolled, CTE completers have the same odds of earning a Bachelor’s degree as non-completers after controlling for students’ high school demographic characteristics, achievement, and experiences. Nonetheless, it is important to note that even if they can be as successful as non-completers in 4-year colleges, CTE completers cannot earn these degrees unless they enroll in 4-year colleges—and CTE completers enroll in 4-year colleges at lower rates than non-completers who are similarly qualified.

What other high school factors were associated with graduates postsecondary enrollment, persistence, and completion?

Perhaps the most striking difference that may be observed throughout the results we presented was the difference in postsecondary outcomes between high school graduates who earned Advanced Studies diplomas and those who earned Standard diplomas. For example, Figure 10 shows the percentage of high school graduates who enrolled in college within one-year of graduating high school by diploma type and CTE completer status for the 2008 and 2009 graduating classes. Reviewing the data shows that approximately 40 percent more Advanced Studies diploma-earners enrolled in college within one-year of high school graduation than Standard diploma earners, regardless of CTE status.

Figure 10. Percentage of college-enrolled high school graduates college enrollment within one-year of high school graduation by CTE completer status and high school diploma type



The results of the regression model (see Appendix A) showed that differences associated with diploma type remained strong after adjusting for other factors, such as student demographic characteristics, English learner and disability status, achievement on high school Algebra II and writing tests, and school experiences. The odds of Advanced Studies diploma-earners enrolling in 4-year colleges was approximately 6 times that of Standard diploma earners; the odds of

Advanced Studies diploma-earners enrolling in 2-year colleges was 1.8 times that of Standard diploma-earners. High school graduates who earned other diplomas for which only students with disabilities are eligible had lower odds of enrolling in both 2- and 4-year colleges than Standard diploma-earners.¹¹

High school graduates who earned Advanced Studies diplomas also had more than 2 times the odds of persisting into their fourth year of college, for both 2- and 4-year colleges; had more than 4 times greater chances of earning a Bachelor's degree within 5 years of high school graduation; and had greater odds of earning Associate's degrees.

Other factors were both statistically and practically significant in the regression models. For example, student demographic characteristics, including race/ethnicity and economically disadvantaged status influenced college enrollment, persistence, and completion. Also, achievement on state Algebra II and writing assessments was associated with enrollment, persistence and completion after controlling for other factors. Importantly, however, differences in postsecondary outcomes that we observed between Standard and Advanced Studies diploma-earners were larger than other differences between groups (details are available in [Appendix A](#)). This finding is consistent with previous research, which showed that taking and succeeding in a more rigorous course of study may reduce achievement gaps between different demographic groups ([Garland, et al., 2011](#); [Jonas, et al., 2012](#)).

Summary and recommendations

This research project investigated the influence of CTE program completion on college enrollment within one year of high school graduation, persistence for four years, and graduation within five years. Initial analyses revealed that compared to high school graduates who did not complete a CTE program of study, CTE completers, on average, had lower high school achievement, were more likely to be economically disadvantaged, male, and African American.

On average, a smaller proportion of CTE completers enroll in college and earn degrees. However, statistical analysis suggests that some of these differences are related to students' high school achievement and demographic factors.

Compared to non-completers who had similar high school achievement, demographic characteristics, and high school experiences:

- CTE completers were more likely to enroll in 2-year college;

¹¹ Descriptive statistics for students who earned Virginia's Special and Modified Standard diplomas are not shown due to small sample of such diploma-earners who enrolled in college.

- Had similar chances of persisting in 2-year colleges; and
- Had greater chances of earning an Associate’s degree
- CTE completers were *less likely* to enroll in 4-year colleges;
 - Once enrolled in college, CTE completers had equal chances of persisting in college, and similar chances of earning a 4-year degree.

We found that CTE completers who enrolled in college have similar chances of earning a 4-year degree as non-completers. Nonetheless, CTE completers did not earn 4-year degrees at similar rates because they were less likely to enroll in 4-year colleges. This attainment gap should be further investigated. CTE completers and those helping to guide students into college may be more familiar with 2-year colleges, as a result of the strong ties between many high school CTE programs and community colleges. However, this should in no way limit high school graduates’ opportunity to make informed choices about college enrollment. On average, bachelor-degree earners have higher earnings than associate-degree earners, although this is not the case for all types of college degrees. It is important that high schools support students’ success finding the college match in a fully informed way—that includes understanding college costs and the potential long-term pay-off of different degrees and even different colleges.

The importance of high school course-taking

The Advanced Studies diploma had the strongest unique influence on high school graduates’ college enrollment and completion. This diploma requires students to take a minimum set of courses that most four-year colleges require for admission and, in Virginia’s community colleges, is associated with a higher chance of students enrolling directly and being successful in credit-bearing courses ([Garland, et al., 2011](#); [Jonas, et al., 2012](#)). While previous studies showed that descriptively, a larger proportion of students who earned the Advanced Studies diploma persisted in college and earned degrees (Jonas & Garland, 2014), this study showed that this remains true after controlling for other factors, including school environment, student demographic characteristics, and student achievement factors, including CTE completion status, outcomes on state Algebra II and writing tests and Advanced Placement course participation.

With guidance and support from the state, Virginia’s CTE programs are working towards strengthening local CTE programs of study and integrating rigorous academic content that aligns with a college-preparatory course of study. In their work, educators can strive to integrate the academic content of the Advanced Studies diploma into CTE programs and courses, which will provide students with both rigorous and relevant education they need for long-term success.

Encouraging and restructuring CTE programs to give all high school graduates the opportunity to earn the Advanced Studies diploma is important regardless of students interests in pursuing a 4-year degree or higher. The evidence is clear that high school graduates who earn Virginia’s

Advanced Studies diplomas have a better chance at success in both 2- and 4- year colleges, and, as a result, have more choices about their own futures.

While helping more students earn the Advanced Studies diploma, it is critical that high schools ensure that students' experiences in college-preparatory courses meet external standards, so that students are exposed to and successful in high quality, rigorous courses expected of these graduates. This study showed that high school students' coursework matters more than any other factor in high school that we examined. It is critical, however, that educators understand the importance of maintaining the academic rigor in college preparatory courses. National research makes clear that policy and practices that mandate college preparatory curriculum, on their own, may not lead to increased college attendance or success (Allensworth, Nomi, Montgomery, Lee, & Mazzeo, 2010). Rather, such policies may provide only one piece of the puzzle. In addition to policy changes, it is also critical to build high schools' capacity to engage lower performing students in more rigorous curriculum using different instructional approaches. As well, it is critical that we build school systems' capacity to strengthen students' preparation before they reach high school—throughout grades K-8 (Dougherty & Mellor, 2009).

Recommendations

The results of this study and others strongly suggest that schools and communities should ensure that all students—CTE completers and non-completers—have access and opportunities to successfully complete a program of study that is consistent with Virginia's Advanced Studies diploma. While state policy permits high school students to graduate without completing the minimum requirements of the Advanced Studies diploma, it is important for CTE leaders consider how best to implement the policy and develop practices that promote and strengthens students' preparation for college and careers. CTE programs are in the unique position of already focusing on career skills, and, in Virginia, for several years, have been striving to ensure that more completers earn Advanced Studies diplomas.

To further support of these local efforts, we recommend that state and local CTE leaders focus on the following:

- 1) Start early—not later than 6th grade—to prepare students for success in course content that will enable them to graduate with an Advanced Studies diploma. This will require changes in local practice to strengthen instructional programs, increase differentiation, and increase the availability of support systems for students who are not on track towards earning an Advanced Studies diploma. Such efforts should focus on ensuring students have the right foundational skills in core areas that facilitate success in diverse high school courses.

- 2) Within CTE programs, review course content of existing programs of study to identify gaps and strengthen programs, and validate program content with business and industry. The review should focus on ensuring that all programs of study provide students with access to content they need to earn Virginia’s Advanced Studies diploma, and, encouraging students to take such pathways. Simultaneously, the process should ensure that educators integrate academic, workplace, and technical content in courses, rather than requiring students to take courses that separate content. This combination offers students rigorous and relevant opportunities that prepare them for success after high school. As well, such integrated content ensures that high school graduates are prepared with skills they need to make their own choices about the future—whether graduates’ choices take them into college or other type of postsecondary training, into the military, or directly into a career. Changing CTE programs throughout the state will take time—and requires strong leadership that engages educators, parents, business leaders, and other community leaders in a process that may require significant local change.
- 3) Conduct deeper program reviews that help strengthen administrators’ use of data to guide instructional decisions, strengthen teaching, and improve student outcomes. Part of this process involves the development of leading and lagging indicators of the rigor of high school programs of study. Many Virginia school divisions already document the diploma students are working towards (leading indicator) and earn upon graduation (lagging indicator). With CTE programs, leaders can use these indicators to better understand which students are on which pathway, and to identify programs, schools, or pathways that may hinder students’ ability to earn the more demanding Advanced Studies diploma. Additional information about using data to assess and monitor progress within Virginia’s CTE programs is available in the College and Career Ready Self-Assessment Tool for Virginia Career and Technical Education Programs (Jonas, Flory & Sun, 2013), such as the importance of collecting data on students’ industry credentials earned; participation and success in dual-credit programs; work-based learning experiences; and more.
- 4) VDOE should continue to support local leaders’ successful use of existing data, and help state and local leaders gather additional data that can provide critical information about CTE program effectiveness. Virginia does not currently have access to two critical student outcomes that, if they became available, would provide important information about the impact of CTE programs on student outcomes. These are: a) employment for high school graduates who did not enroll in a Virginia public or non-profit university, and b) graduates’ military enlistment. In particular, understanding employment outcomes for CTE completers who do not enroll in college is a high priority for VDOE’s CTE leaders. To enable Virginia to connect de-identified high school records to de-identified state

employment records using VLDS, Virginia would need to add another agency to the system that can independently connect to VDOE and VEC records. Other states have demonstrated success by incorporating records from the Department of Motor Vehicles (see [Barrera, Singletary, & Brown, 2013](#)).

- 5) VDOE's CTE office should continue to leverage VLDS to assess the long-term outcomes of CTE completers to gain a more nuanced understanding of the benefits of CTE participation for high school students. This project, which includes the results presented in this paper and those presented in Yamaguchi and colleagues (2014), provided leaders with a high-level picture of 4- and 5-year outcomes for CTE completers. However, additional information is important to continue to provide data-based information to state and local program leaders. For example, given the state and national focus on industry credentialing, it would be useful to conduct research specifically focused on understanding outcomes of students who earned industry credentials in high school. Another important direction for research would be to develop a clear understanding of long-term outcomes for CTE completers who participated in different career pathways in high school. Having this information can provide students with direct evidence to help them make course-taking decisions.

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Appendix A. Multinomial logistic regression methods and results

In this study, we used multivariate regression models to interpret whether descriptive differences between outcomes for CTE completers and non-completers were meaningful. We developed separate models for outcomes related to enrollment, persistence, and completion. To analyze data for each of these key outcomes, we operationalized each response variable as an unordered, categorical indicator. For each outcome, we modeled the association between the covariates and the response variables by fitting a multinomial logistic regression. Response variables (outcomes) used in each model are shown in figure A-1.

Figure A-1. Response variables used in each multinomial logistic regression model

<ul style="list-style-type: none"> • Enrollment (base outcome = no enrollment) <ul style="list-style-type: none"> ○ Enrollment in 2-year colleges ○ Enrollment in 4-year colleges. • Persistence* (base outcome = did not persist) <ul style="list-style-type: none"> ○ Persisted into year 2 ○ Persisted into year 3 ○ Persisted into year 4 • College completion (base outcome = no college credential earned) <ul style="list-style-type: none"> ○ Associate’s degree or certificate ○ Bachelor’s degree ○ Bachelor’s degree <i>and</i> Associate’s degree

*We estimated separate persistence models for high school graduates who first enrolled in 2-year colleges and those who first enrolled in 4-year colleges.

Table A-1. Description of covariates used in multinomial regression models

Variable Name	Variable description
Student Demographic Characteristics¹²	
Economically disadvantaged status	Economically disadvantaged status
Limited English proficient status	Limited English Proficient status
Gender	Student gender
Student Race/Ethnicity	Student's race category
Student had at least one primary disability	Student had at least one primary disability code
High School Experience and Achievement	
CTE completer status	CTE completer status upon high school graduation

¹² Visit VDOE’s Specifications for [Student Record Collection](#) for more details on each of these variables.

Participated in Advanced Placement (AP®) program	Participated in AP course, test, both, or none
Algebra II proficiency level	Level of proficiency as defined on Virginia Algebra II test (no score, fail, proficient, advanced)
11th grade writing proficiency level	Level of proficiency as defined on Virginia's 11th grade writing test (no score, fail, proficient, advanced)
Diploma type	Virginia high school diploma type (Advanced Studies, Standard, other)
Attendance rate	Percent of total days student present at school

High School Characteristics

HS Algebra II	High school mean Algebra II SOL scaled score (range, 0-600)
Attendance rate, school average	High school mean attendance rate
Percent economically disadvantaged, school level	High school percentage who were economically disadvantaged
11th grade writing scaled score, school average	High school mean English/Writing SOL scaled score (range, 0-600)
Percent CTE completers, school level	High school percentage who were CTE completers
Average ACT/SAT math score, school-level	High school mean combined SAT/ACT mathematics score based on data from VDOE and public concordance tables
Average ACT/SAT English score, school-level	High school mean combined SAT/ACT English score based on data from VDOE and public concordance tables

As an illustration, we describe the model used for initial college enrollment. For this model, our response variable for student i (Y_i) has three potential outcomes: no enrollment ($Y_i=0$), enrollment in a 2-year college ($Y_i=1$), and enrollment in a 4-year college ($Y_i=2$). The response categories were unordered and are mutually exclusive: student i 's *known and measured* post-high school graduation outcomes fit only into one of these three buckets. More generally, the multinomial logit model estimates the log-odds of outcome(s) (in this case, enrollment in a 2-year college) relative to the base outcome (t) (no postsecondary enrollment):

$\log\left(\frac{\pi_i^{(s)}}{\pi_i^{(t)}}\right)$ conditioned on a vector of student-level characteristics, or $\log\left(\frac{\pi_i^{(s)}}{\pi_i^{(t)}}\right)=a_j + \beta_j \mathbf{x}_i$, where a_j is the model constant; β_j is a vector of estimated coefficients and j represents the response categories $j=0, 1, \text{ or } 2$; and \mathbf{x}_i is a matrix of student- and school-level covariates, which included

demographic characteristics, program participation, and high school achievement outcomes (see Table A-1).

This specification allowed the research team to separately estimate the impact of CTE participation (and other covariates) on the likelihood of the response category of interest (e.g., enrolling in a 2-year college; persisting into the 4th year; earning a Bachelor's degree) relative to a base outcome (for instance, not enrolling; not persisting; not earning the degree). This is important, since different student characteristics and decisions are likely differentially associated with the each outcome relative to the base category. We then transformed the coefficients into relative risk ratios by exponentiating the log-odds to facilitate interpretation. Each model's standard errors are adjusted to account for clustering based on students' high school of attendance.

Results of the multinomial regression models

The following tables (Tables A-2, A-3, A-4, and A-5) display the results of the regression models for college enrollment, persistence and completion. These models resulted in odds ratios, which allowed us to compare the degree to which each factor (e.g., CTE completion, different achievement levels, and students' socio-economic status) influenced students' likelihood of being employed while in college.

In the results tables, we identified the outcomes that were statistically significant with asterisks (*). However, given the large sample size, we also recognize that some of the statistically significant results may have limited practical significance. As such, we used the following guide to interpret the odds ratios throughout the paper.

- Odds ratios of 1.0 (OR = 1): CTE completion (or other variable) did not influence the odds of the target outcome (i.e., enrollment, persistence, or completion).
- Odds ratios greater than 1.0 (OR > 1): CTE completion (or other variable) was associated with *higher* odds of the target outcome occurring (i.e., enrollment, persistence, or completion).
- Odds ratios less than 1.0 (OR < 1): CTE completion (or other variable) was associated with *lower* odds of the target outcome occurring (i.e., enrollment, persistence, or completion).

When interpreting odds ratios, the magnitude is important. Odds ratios ranging from .90 – 1.10 were not considered meaningfully different from 1.0, even if they were statistically significant.

Table A-2. Results of multinomial regression models for high school graduates college enrollment within one year of high school graduation

Odds of enrolling in college within one year of graduating high school					
	2008 graduates		2009 graduates		Reference group (categorical variables only)
	2-year or less than 2-year college	4-year college	2-year or less than 2-year college	4-year college	
CTE completer	1.06* (0.03)	0.85*** (-0.02)	1.09*** (-0.02)	0.87*** (-0.02)	Non-completers
Diploma type= Advanced Studies/IB	1.78*** (0.07)	6.52*** (0.29)	1.71*** (0.06)	5.95*** (0.31)	Standard diploma
Diploma type= Special	0.20*** (0.03)	0.15*** (0.03)	0.14*** (0.02)	0.11*** (0.03)	Standard diploma
Diploma type= Modified	0.61*** (0.05)	0.23*** (0.04)	0.55*** (0.04)	0.34*** (0.06)	Standard diploma
Algebra II proficiency level=No score	0.48*** (0.02)	0.46*** (0.02)	0.48*** (0.01)	0.30*** (0.01)	Proficient
Algebra II proficiency level=Fail	0.94 (0.04)	0.68*** (0.04)	0.93 (0.04)	0.68*** (0.04)	Proficient
Algebra II proficiency level=Advanced	0.64*** (0.03)	1.22*** (0.05)	0.67*** (0.04)	1.36*** (0.07)	Proficient
11th grade writing proficiency level=No score	0.56*** (0.04)	1.01 (0.13)	0.69*** (0.05)	1.18 (0.11)	Proficient
11th grade writing proficiency level=Fail	0.62*** (0.05)	0.56*** (0.08)	0.69*** (0.05)	0.58*** (0.06)	Proficient
11th grade writing proficiency level=Advanced	0.97 (0.03)	1.71*** (0.06)	1.02 (0.03)	1.81*** (0.06)	Proficient
Attendance rate, student level	1.04*** (0.00)	1.08*** (0.00)	1.04*** (0.00)	1.08*** (0.00)	

**Odds of enrolling in college within one year of
graduating high school**

	2008 graduates		2009 graduates		Reference group (categorical variables only)
	2-year or less than 2-year college	4-year college	2-year or less than 2-year college	4-year college	
Participated in Advanced Placement (AP®) program	0.87** (0.04)	2.70*** (0.13)	1.01 (0.05)	2.98*** (0.14)	No AP participation
Race/ethnicity=Unspecified	1.00 (0.10)	1.20 (0.13)	0.99 (0.08)	0.92 (0.09)	White
Race/ethnicity=American Indian	0.72 (0.14)	0.78 (0.15)	0.93 (0.18)	0.85 (0.19)	White
Race/ethnicity=Asian	1.45*** (0.10)	1.23* (0.10)	1.40*** (0.10)	1.09 (0.09)	White
Race/ethnicity=African American	0.85*** (0.03)	1.84*** (0.10)	0.93* (0.03)	2.13*** (0.11)	White
Race/ethnicity=Hispanic	0.90* (0.05)	0.48*** (0.03)	0.89* (0.04)	0.49*** (0.03)	White
Economically disadvantaged status	0.75*** (0.02)	0.60*** (0.02)	0.77*** (0.02)	0.60*** (0.02)	Not economically disadvantaged
Gender	0.77*** (0.02)	0.82*** (0.02)	0.75*** (0.02)	0.78*** (0.02)	Female
Student had at least one primary disability	1.30*** (0.05)	1.09 (0.05)	1.29*** (0.04)	1.07 (0.05)	No primary disability
Limited English proficient status	0.85* (0.06)	0.48*** (0.04)	1.00 (0.07)	0.48*** (0.05)	No LEP flag
Algebra II scaled score, school average	1.01*** (0.00)	1.00 (0.00)	1.00** (0.00)	1.00 (0.00)	
11th grade writing scaled score, school average	1.01*** (0.00)	1.01*** (0.00)	1.01*** (0.00)	1.01*** (0.00)	

Odds of enrolling in college within one year of graduating high school

	2008 graduates		2009 graduates		Reference group (categorical variables only)
	2-year or less than 2-year college	4-year college	2-year or less than 2-year college	4-year college	
Attendance rate, school average	0.98 (0.01)	0.94*** (0.02)	0.97** (0.01)	0.95** (0.02)	
Average ACT/SAT math score, school-level	0.94 (0.04)	1.17** (0.07)	1.02 (0.04)	1.25*** (0.07)	
Average ACT/SAT English score, school-level	0.98 (0.03)	0.91* (0.04)	0.96 (0.03)	0.87** (0.04)	
Percent economically disadvantaged, school level	0.98 (0.19)	1.07 (0.36)	1.26 (0.30)	1.12 (0.40)	
Percent CTE completers, school level	1.01 (0.00)	0.80 (0.01)	0.84 (0.00)	0.79 (0.01)	
Constant	0.00*** (0.00)	0.00*** (0.00)	0.00*** (0.00)	0.00*** (0.00)	
Observations (N)	74817		79836		
Clusters (N)	323		327		

Notes: Depicted are odds ratio for enrollment status; * p<.05; ** p<.01; *** p<.001. Standard errors adjusted to account for clustering at the student's high school are shown in parenthesis.

Base outcome is no enrollment record.

Table A-3. Results of multinomial regression models, college-enrolled students' persistence rates, high school graduates who first enrolled in 2-year colleges

Persistence for college-enrolled high school graduates who first enrolled in 2-year colleges						
	2008 graduates			2009 graduates		Reference group (categorical variables only)
	2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence	
CTE completer status	0.99 (0.05)	1.04 (0.06)	1.07 (0.04)	0.98 (0.04)	1.03 (0.04)	Non-completers
Diploma type=Advanced Studies/IB	1.21** (0.07)	1.33*** (0.09)	2.19*** (0.10)	1.18** (0.06)	1.85*** (0.08)	Standard diploma
Algebra II proficiency level=No score	0.90 (0.05)	0.75*** (0.05)	0.67*** (0.03)	0.83*** (0.05)	0.61*** (0.03)	Proficient
Algebra II proficiency level=Fail	0.92 (0.07)	0.83* (0.08)	0.77*** (0.05)	0.88 (0.07)	0.82** (0.05)	Proficient
Algebra II proficiency level=Advanced	0.99 (0.11)	1.01 (0.13)	1.19* (0.10)	0.92 (0.09)	1.11 (0.08)	Proficient
11th grade writing proficiency level=No score	0.95 (0.18)	0.98 (0.23)	1.06 (0.17)	0.83 (0.13)	0.93 (0.11)	Proficient
11th grade writing proficiency level=Fail	0.99 (0.22)	0.87 (0.24)	1.04 (0.20)	0.67* (0.12)	0.82 (0.11)	Proficient
11th grade writing proficiency level=Advanced	1.00 (0.07)	0.98 (0.08)	1.16** (0.06)	0.98 (0.06)	1.05 (0.05)	Proficient

Persistence for college-enrolled high school graduates who first enrolled in 2-year colleges

	2008 graduates			2009 graduates		Reference group (categorical variables only)
	2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence	
Participated in Advanced Placement (AP®) program	1.11 (0.08)	1.08 (0.10)	1.37*** (0.08)	1.15* (0.08)	1.48*** (0.08)	No AP participation
Attendance rate, student level	1.02*** (0.00)	1.02*** (0.00)	1.05*** (0.00)	1.01* (0.00)	1.03*** (0.00)	White
Race/ethnicity= Unspecified	1.01 (0.24)	1.26 (0.33)	1.15 (0.22)	1.32 (0.24)	1.25 (0.18)	White
Race/ethnicity= American Indian	2.90* (1.45)	2.15 (1.31)	1.80 (0.84)	0.37* (0.19)	0.96 (0.27)	White
Race/ethnicity= Asian	1.47** (0.21)	1.76*** (0.27)	2.54*** (0.28)	1.52** (0.20)	2.67*** (0.27)	White
Race/ethnicity= African American	1.11 (0.07)	1.25** (0.09)	0.91 (0.05)	1.17** (0.06)	0.94 (0.04)	White
Race/ethnicity= Hispanic	1.03 (0.11)	1.24 (0.15)	1.19* (0.10)	1.06 (0.10)	1.20** (0.08)	White
Economically disadvantaged status	0.95 (0.06)	0.82* (0.06)	0.80*** (0.04)	0.81*** (0.04)	0.69*** (0.03)	Not economically disadvantaged
Gender	0.86** (0.04)	0.87** (0.05)	0.78*** (0.03)	0.81*** (0.03)	0.70*** (0.02)	Female
Student had at least one primary disability	1.15 (0.09)	1.15 (0.10)	1.14* (0.07)	1.21** (0.08)	1.18** (0.06)	No primary disability
Limited English proficient status	1.13 (0.20)	2.09*** (0.36)	1.93*** (0.26)	1.21 (0.17)	1.93*** (0.20)	No LEP flag

Persistence for college-enrolled high school graduates who first enrolled in 2-year colleges

	2008 graduates			2009 graduates		Reference group (categorical variables only)
	2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence	
Algebra II scaled score, school average	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	
11th grade writing scaled score, school average	1.00 (0.00)	1.00 (0.00)	1.01*** (0.00)	1.00 (0.00)	1.01** (0.00)	
Attendance rate, school average	0.99 (0.01)	0.97 (0.02)	0.96*** (0.01)	1.01 (0.01)	0.99 (0.01)	
Average ACT/SAT math score, school-level	0.97 (0.04)	1.02 (0.05)	1.06 (0.04)	1.10** (0.04)	1.11*** (0.03)	
Average ACT/SAT English score, school-level	1.04 (0.04)	1.04 (0.05)	1.00 (0.03)	0.92* (0.03)	0.95* (0.02)	
Percent economically disadvantaged, school level	0.97 (0.22)	1.46 (0.40)	1.39 (0.26)	1.39 (0.32)	1.50* (0.27)	
Percent CTE completers, school level	0.95 (0.16)	0.94 (0.19)	1.07 (0.15)	1.17 (0.18)	1.05 (0.13)	
Constant	0.06 (0.09)	0.03 (0.05)	0.00*** (0.00)	0.01*** (0.01)	0.00*** (0.00)	

Observations (N) 19321

22370

Notes: Depicted are odds ratio for persistence into each subsequent year; * p<.05; ** p<.01; *** p<.001.

Standard errors adjusted to account for clustering at the student's high school are shown in parenthesis.

Persistence for college-enrolled high school graduates who first enrolled in 2-year colleges						
2008 graduates			2009 graduates			Reference group (categorical variables only)
2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence		

Only students who earned a Standard or Advanced Diploma are included in the statistical models due to small cell sizes and over-determination.

Less-than-two-year colleges have been collapsed with 2-year colleges for estimation efficiency purposes
Base category is did not persist into the next year

Table A-4. Results of multinomial regression models, college-enrolled students' persistence rates, high school graduates who first enrolled in 4-year colleges

Persistence for college-enrolled high school graduates who first enrolled in 4-year colleges						
2008 graduates			2009 graduates			Reference group (categorical variables only)
2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence		
CTE completer status	1.00 (0.08)	1.01 (0.08)	1.06 (0.06)	0.98 (0.07)	1.00 (0.06)	Non-completers
Diploma type= Advanced Studies/IB	1.20* (0.10)	1.53*** (0.14)	2.98*** (0.19)	1.40*** (0.12)	2.43*** (0.16)	Standard diploma
Algebra II proficiency level=No score	0.83 (0.08)	0.76** (0.08)	0.83** (0.06)	0.83 (0.10)	0.70*** (0.06)	Proficient
Algebra II proficiency level=Fail	0.92 (0.14)	0.91 (0.15)	0.94 (0.11)	0.92 (0.13)	0.73** (0.08)	Proficient
Algebra II proficiency level=Advanced	0.92 (0.10)	0.89 (0.10)	1.38*** (0.11)	0.86 (0.09)	1.53*** (0.12)	Proficient
11th grade writing proficiency level=No score	1.05	0.87	0.95	0.97	1.01	Proficient

Persistence for college-enrolled high school graduates who first enrolled in 4-year colleges

	2008 graduates			2009 graduates		Reference group (categorical variables only)	
	Odds of persisting in college						
	2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence		
	(0.24)	(0.22)	(0.17)	(0.21)	(0.17)		
11th grade writing proficiency level=Fail	1.08	0.69	0.85	0.51	0.59	Proficient	
	(0.46)	(0.37)	(0.30)	(0.24)	(0.18)		
11th grade writing proficiency level=Advanced	0.84*	0.90	1.13	0.89	1.17*	Proficient	
	(0.07)	(0.08)	(0.07)	(0.07)	(0.07)		
Participated in Advanced Placement (AP®) program	1.25**	1.31**	2.05***	0.98	1.64***	No AP participation	
	(0.11)	(0.11)	(0.13)	(0.08)	(0.10)		
Attendance rate, student level	1.03***	1.02**	1.08***	1.02***	1.09***		
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)		
Race/ethnicity=Unspecified	1.30	1.13	1.25	1.17	0.97	White	
	(0.43)	(0.40)	(0.32)	(0.32)	(0.21)		
Race/ethnicity=American Indian	1.34	1.83	0.56	0.89	0.38**	White	
	(0.79)	(1.06)	(0.27)	(0.39)	(0.13)		
Race/ethnicity=Asian	1.03	1.18	1.36*	0.92	1.24	White	
	(0.20)	(0.23)	(0.20)	(0.18)	(0.17)		
Race/ethnicity=African American	1.10	1.21	0.90	1.09	0.92	White	
	(0.10)	(0.12)	(0.06)	(0.10)	(0.06)		
Race/ethnicity=Hispanic	0.97	1.36	0.89	1.13	1.09	White	
	(0.20)	(0.28)	(0.14)	(0.23)	(0.17)		

Persistence for college-enrolled high school graduates who first enrolled in 4-year colleges

	2008 graduates			2009 graduates		Reference group (categorical variables only)	
	Odds of persisting in college						
	2nd year persistence	3rd year persistence	4th year persistence	2nd year persistence	3rd year persistence		
Economically disadvantaged status	0.68*** (0.07)	0.65*** (0.07)	0.55*** (0.04)	0.81* (0.07)	0.57*** (0.04)	Not economically disadvantaged	
Gender	0.98 (0.07)	1.12 (0.08)	0.65*** (0.04)	1.02 (0.07)	0.65*** (0.03)	Female	
Student had at least one primary disability	1.01 (0.16)	1.17 (0.19)	1.20 (0.14)	0.97 (0.15)	1.16 (0.13)	No primary disability	
Limited English proficient status	1.47 (0.51)	1.06 (0.40)	1.53 (0.42)	0.81 (0.28)	1.26 (0.30)	No LEP flag	
Algebra II scaled score, school average	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)		
11th grade writing scaled score, school average	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)		
Attendance rate, school average	0.98 (0.02)	0.97 (0.02)	0.94*** (0.02)	0.97 (0.02)	0.92*** (0.01)		
Average ACT/SAT math score, school-level	0.99 (0.07)	1.07 (0.08)	1.14* (0.06)	1.01 (0.06)	1.17*** (0.06)		
Average ACT/SAT English score, school-level	1.01 (0.06)	1.02 (0.07)	1.00 (0.05)	1.01 (0.06)	0.94 (0.04)		

Table A-5. Multinomial regression results, college-enrolled students' odds of earning a college credential

College credentials earned: college-enrolled high school graduates								
	2008 graduates (5 years after high school graduation)			2009 graduates (4 years after high school graduation)			Reference group (categorical variables only)	
	Odds of earning college credentials							
	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree		
CTE completer status	1.21*** (0.06)	0.92** (0.03)	1.12 (0.07)	1.24*** (0.06)	0.82*** (0.04)	1.07 (0.10)	Non-completers	
Diploma type= Advanced Studies/IB	1.42*** (0.10)	4.35*** (0.55)	2.45*** (0.32)	1.24** (0.09)	4.26*** (0.59)	2.15** (0.59)	Standard diploma	
Diploma type= Special	0.63 (0.27)	2.90** (1.00)	0.00*** (0.00)	0.36 (0.32)	1.06 (0.80)	10.59*** (6.59)	Proficient	
Diploma type= Modified	0.92 (0.21)	0.40** (0.13)	1.12 (0.89)	0.80 (0.37)	0.82 (0.42)	2.15 (1.19)	Proficient	
Algebra II proficiency level=No score	0.75*** 0.06	1.01 (0.07)	0.70* (0.11)	0.63*** (0.06)	0.67*** (0.06)	0.46** (0.11)	Proficient	
Algebra II proficiency level=Fail	0.81*** (0.05)	0.65*** (0.05)	0.46*** (0.08)	0.71*** (0.04)	0.56*** (0.07)	0.54*** (0.09)	Proficient	

College credentials earned: college-enrolled high school graduates								
	2008 graduates (5 years after high school graduation)			2009 graduates (4 years after high school graduation)			Reference group (categorical variables only)	
	Odds of earning college credentials							
	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree		
Algebra II proficiency level=Advanced	0.97 (0.06)	1.84*** (0.15)	1.47*** (0.17)	0.83** (0.05)	1.81*** (0.15)	1.36*** (0.10)	Proficient	
11th grade writing proficiency level=No score	0.83 (0.12)	1.44*** (0.15)	1.88*** (0.35)	0.99 (0.16)	1.48* (0.24)	0.96 (0.38)	Proficient	
11th grade writing proficiency level=Fail	1.17 (0.16)	0.67 (0.15)	0.37 (0.24)	0.63** (0.09)	0.17** (0.10)	1.26 (0.62)		
11th grade writing proficiency level=Advanced	0.90* (0.04)	1.66*** (0.08)	1.32*** (0.08)	0.88** (0.04)	1.74*** (0.09)	1.45*** (0.11)	White	
Participated in Advanced Placement (AP®) program	0.82* (0.06)	2.37*** (0.18)	1.20 (0.12)	0.71** (0.09)	2.09*** (0.14)	1.12 (0.15)	White	

College credentials earned: college-enrolled high school graduates								
	2008 graduates (5 years after high school graduation)			2009 graduates (4 years after high school graduation)			Reference group (categorical variables only)	
	Odds of earning college credentials							
	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree		
Attendance rate, student level	1.03*** (0.01)	1.10*** (0.01)	1.09*** (0.01)	1.04*** (0.01)	1.11*** (0.01)	1.11*** (0.02)		
Race/ethnicity= Unspecified	0.65** (0.11)	0.90 (0.11)	0.96 (0.27)	0.95 (0.15)	0.86 (0.08)	0.69 (0.20)	White	
Race/ethnicity= American Indian	0.66 (0.18)	0.64* (0.14)	0.51 (0.28)	0.85 (0.18)	0.64 (0.16)	0.70 (0.48)	White	
Race/ethnicity= Asian	1.07 (0.20)	0.96 (0.10)	1.04 (0.17)	1.22 (0.31)	0.91 (0.08)	0.98 (0.20)	White	
Race/ethnicity= African American	0.42*** (0.05)	0.89 (0.07)	0.37*** (0.04)	0.37*** (0.04)	0.81* (0.07)	0.41*** (0.07)	White	
Race/ethnicity= Hispanic	1.02 (0.08)	0.58** (0.12)	0.78 (0.11)	1.06 (0.10)	0.62** (0.12)	1.04 (0.13)	White	
Economically disadvantaged status	0.93 (0.05)	0.67*** (0.05)	0.81 (0.16)	1.01 (0.08)	0.64*** (0.05)	0.74 (0.16)	Not economically disadvantaged	
Gender	0.66***	0.61***	0.61***	0.69***	0.56***	0.51***	Female	

College credentials earned: college-enrolled high school graduates								
	2008 graduates (5 years after high school graduation)			2009 graduates (4 years after high school graduation)			Reference group (categorical variables only)	
	Odds of earning college credentials							
	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree		
Student had at least one primary disability	(0.03) 0.98 (0.07)	(0.02) 0.72** (0.08)	(0.04) 0.70*** (0.07)	(0.03) 1.10 (0.06)	(0.02) 0.68*** (0.06)	(0.05) 0.51*** (0.10)	No primary disability	
Limited English proficient status	1.38*** (0.10)	0.82 (0.17)	1.32** (0.12)	1.58*** (0.09)	0.66* (0.12)	1.62** (0.24)	No LEP flag	
Algebra II scaled score, school average	1.00* (0.00)	1.00 (0.00)	1.00 (0.00)	1.00 (0.00)	1.00** (0.00)	1.01 (0.00)		
11th grade writing scaled score, school average	1.00 (0.00)	1.00 (0.00)	1.01* (0.01)	1.00 (0.00)	1.00 (0.00)	1.01 (0.01)		
Attendance rate, school average	0.98 (0.02)	0.94** (0.02)	0.95** (0.02)	0.96** (0.02)	0.95* (0.02)	0.93* (0.03)		
Average ACT/SAT math score, school-level	0.92 (0.06)	1.24** (0.09)	0.95 (0.07)	0.90 (0.06)	1.22*** (0.06)	0.94 (0.08)		



College credentials earned: college-enrolled high school graduates								
	2008 graduates (5 years after high school graduation)			2009 graduates (4 years after high school graduation)			Reference group (categorical variables only)	
	Odds of earning college credentials							
	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree	Associate's degree or certificate	Bachelor's degree (only)	Bachelor's and Associate's degree		
Average ACT/SAT English score, school-level	1.07 (0.05)	0.98 (0.08)	1.07 (0.07)	1.06 (0.04)	0.95 (0.05)	1.01 (0.07)		
Percent economically disadvantaged, school level	2.84** (0.97)	1.79 (0.64)	3.00* (1.37)	2.39** (0.79)	1.23 (0.32)	3.31* (1.85)		
Percent CTE completers, school level	1.67** (0.28)	0.82 (0.15)	1.49 (0.43)	1.66* (0.40)	1.08 (0.22)	1.93 (0.95)		
Constant	0.01* (0.02)	0.00*** (0.00)	0.00*** (0.00)	0.04 (0.07)	0.00*** (0.00)	0.00* (0.00)		
Observations (N)	52830			56233				

Notes: Depicted are odds ratio for persistence into each subsequent year; * p<.05; ** p<.01; *** p<.001. Standard errors adjusted to account for clustering at the student's high school are shown in parenthesis. Base outcome is no credential. Standard errors, shown in parenthesis, are clustered at student's first college. Less-than-two-year colleges have been collapsed with 2-year colleges for estimation efficiency purposes.