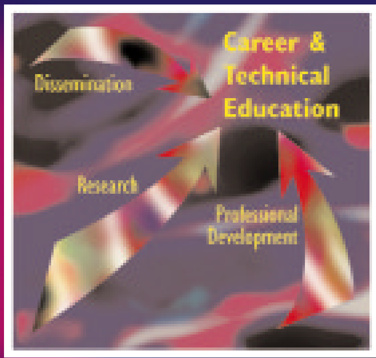

Career and Technical Education in the Balance: An Analysis of High School Persistence, Academic Achievement, and Postsecondary Destinations

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ABSTRACT

Educators, researchers, and policymakers are currently examining the ways that career and technical education (CTE) is—and could be—coupled with core academic education in U.S. high schools. Efforts to integrate vocational and college preparatory course-taking in meaningful and effective ways have been gaining attention and momentum since the passage of the 1990 Perkins Act. These efforts have been further augmented the 1998 Perkins Act. However, attempts to integrate CTE and academic courses have been taking place on the heels of declining rates of high school vocational course-taking witnessed during the 1980s and early 1990s.

This study discusses how CTE and academic curricula can, or should, co-exist in U.S. high schools. The study examines the relationship between (a) the balance struck between CTE and academic course-taking during the high school years, and (b) academic achievement, persistence in high school, and postsecondary destinations. Data come from the National Education Longitudinal Study of 1988. The surveys, cognitive tests, and high school transcript information used in the analyses were collected between 1988, when sample members were eighth graders in U.S. schools, and 1994, when most sample members were two years beyond high school graduation.

The balance struck between CTE and academic course-taking is measured in two ways. For analyses of 1992 cognitive test scores and for analyses of postsecondary destinations, each sample member is classified as either (a) an academic concentrator, (b) a CTE concentrator, (c) a dual concentrator, or (d) one who fulfilled neither concentration. An academic concentration requires fulfillment of a standard—if somewhat lenient—version of the New Basics (completing four Carnegie units of English and three Carnegie units in each of mathematics, science, and social studies during high school). A CTE concentration requires earning at least three Carnegie credits in any one of eleven Specific Labor Market Preparation vocational areas.

For analyses of the likelihood of dropping out of high school, a different measure of an individual's balance between CTE and academic course-taking is used. This alternative measurement is the ratio of CTE credits earned to academic credits earned. The methodological and conceptual reasons for the change in measurement are explained within this paper.

Analyses of academic achievement show significant associations between high school course-taking patterns and 1992 test scores in reading, mathematics, science, and history, controlling for gender, race/ethnicity, socioeconomic status, and eighth-grade test scores. Specifically, academic concentrators exhibit the highest 1992 achievement in each subject area, after background controls are taken into account. Following them by a small but statistically significant margin are dual concentrators. The third-highest scoring group are those students who fulfilled neither concentration, followed by the CTE concentrators. Evidence is presented to show that part of the achievement advantage enjoyed by purely academic concentrators may be linked to the greater number of credits they amass in advanced academic topics.

Analyses of the likelihood of dropping out reveal an intriguing curvilinear pattern. After controlling for prior achievement, grades, and student background characteristics, the risk of dropping out is estimated to be at its lowest near the point at which a student completes three Carnegie units of CTE for every four Carnegie units of academic subjects. As the CTE-to-academic ratio gets smaller (closer to zero) or larger (rising above 0.77), the risk of dropping out

is estimated to increase. The salience of this curvilinear relationship appears to be strongest for students who are already at relatively high risk of dropping out (due to low prior test scores or low grades, for example). Possible explanations for the curvilinear finding are discussed. Also, the author suggests that—if it is indeed true that a middle-range mix of CTE and academic course-taking can lower the risk of dropping out for some students—educators and policymakers might be wise to encourage such a mix, even if it brings slight reductions in standardized test scores in core academic subjects. Given the importance of a high school diploma in our society, slight reductions in test scores might be found acceptable in exchange for higher graduation rates.

Finally, analyses of postsecondary destinations reveal several noteworthy points. For example, almost all students in this national sample were engaged in postsecondary schooling or paid employment, or both, during what was, for most of them, the first full calendar year after high-school graduation. This in itself is encouraging news. Secondly, substantial numbers of individuals from each of the four featured high school course-taking sequences (purely academic concentrators, purely CTE concentrators, dual concentrators, and those who had neither high school concentration) pursued postsecondary education; and substantial numbers of students from each course-taking sequence pursued paid employment. Individuals did seem to reach the end of high school with multiple options before them.

Nonetheless, while none of the curricular concentrations during high school completely precluded any of the postsecondary paths analyzed in this report, the curricular concentrations did affect an individual’s probability of following one path or another. Controlling for gender, race, SES, and pre-high school achievement, purely academic concentrators were most likely to become purely or primarily students during 1993. They were followed by dual concentrators, those who had neither high school concentration, and, finally, purely CTE concentrators. Conversely, regarding the world of work, purely CTE concentrators were most likely to become purely or primarily workers in 1993. They were followed by those who had neither high school concentration, dual concentrators, and, finally, purely academic concentrators. In some ways, the results of the analyses of the postsecondary destinations contained few surprises. But they do serve to suggest that the balance struck between CTE and academic course-taking does affect an individual’s destination after high school. And the results also suggest that some of the goals of efforts to integrate CTE and academic offerings—such as allowing individuals to have multiple attractive options available after high school—are being met at a most basic level. The report concludes by highlighting a series of issues deserving of further investigation.

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INTRODUCTION

As a society, we ask a lot of our high schools. We ask them to promote students' proficiency in multiple core academic areas. We ask them to prepare individuals for postsecondary endeavors, whether participation in the labor force, continuing education, or both. We ask high schools to develop or encourage certain socially desired behaviors, attitudes, and capacities in students, while discouraging or sanctioning other traits and behaviors. And—as we ask schools to pursue these varied and sometimes competing goals—we hope they will make the experience engaging and rewarding enough to convince students to remain within the formal educational system at least until high school graduation. We hope students will persist to graduation, rather than dropping out of school.

Not only does society present high schools with a diverse set of goals, our demographic and social make-up also presents high schools with a diverse set of students to be guided and educated. Individuals enter high schools with different levels of academic preparation, a variety of home and neighborhood backgrounds, varying degrees of commitment to formal educational endeavors, and a wide range of goals, desires, and expectations for the years after high school.

Not surprisingly, in the face of multiple societal mandates and diverse student populations, high schools in the United States have come to offer multiple and varying curricular paths for students to follow (Hallinan, 1994; Oakes, 1994; Oakes, Gamoran, & Page, 1992; Powell, Farrar, & Cohen, 1985). Which path a student will follow—what balance of specializations and subject areas he or she will be exposed to—is partly a matter of individual choice and partly a matter of being guided or placed by the adults and sorting mechanisms of schools as organizations (Garet & DeLany, 1988).

Career and technical education (vocational coursework) is a notable part of the mix. For many decades, high schools seemed to focus on preparing students for *either* entry-level jobs *or* postsecondary education. Students who were being guided toward labor force entry immediately after secondary school often completed many of their high school credits in areas such as trade, industry, business, agriculture, marketing, and distribution. Students being prepared for postsecondary education generally took fewer of these vocational courses, and instead completed more credits in mathematics, science, English, social studies, and foreign language.

These two distinct paths of vocational concentration and college preparation (and others that completed the menu of available options) have not ceased to exist. However, a couple of trends have altered the landscape of the U.S. high school. First, during the 1980s and into the 1990s, the amount of high school vocational course-taking declined, while academic course-taking increased (Hoachlander, Kaufman, Levesque, & Houser, 1992; Levesque et al., 1995; Levesque, Lauen, Teitelbaum, Alt, & Librera, 2000). The reasons for this shifting balance are surely complex, but contributing factors included changes in high school graduation requirements and changes in the skill sets and training levels demanded by the labor market (National Center for Education Statistics, 2000).

Second, explicit attempts to combine vocational education with a solid academic grounding have become increasingly common. One central goal of such integrated programs is to keep individuals' options open until after high school. If high-quality preparation in core academic subjects can be coupled with a strong foundation in work skills and applications, it is hoped that upon high school graduation individuals will have attractive options available in multiple arenas: in two- or four-year colleges; within the paid labor force; or in pursuing postsecondary education and paid employment simultaneously.

Advocates of combining vocational concentration with college preparation also suggest motivational benefits. In light of increasingly stringent high school graduation requirements in most states, we can assume that almost all high school students will be exposed to more core academic subjects (in particular, English, mathematics, science, and social studies) than would have been typical 10 or 20 years ago. Given this fact, are there reasons to expect that students will perceive greater relevance in academic subjects, apply greater effort to their academic courses, or develop firmer commitment to school, generally, if academic studies are coupled with career and technical education (CTE)? Many argue that, indeed, there are reasons to expect these motivational benefits.

Positing such potential benefits, Crain et al. (1998) studied students' experiences in career-focused magnet high schools. In describing an ideal in career magnet design and implementation, Crain and his colleagues seem to hypothesize the greatest potential benefits for students exhibiting average or somewhat-below-average achievement levels upon entering high school. Their comments about potential benefits of career magnet programs can logically be extended to efforts to combine CTE and academic course-taking more broadly. They wrote the following:

> Abstract academic education not connected to a specific career can be satisfying only to those students who are certain they will get a four-year college degree that will meet their career-preparation needs. Contrasted with the traditional high school, career magnets can command the loyalty of their students and offer them an opening to a future career that does not require them to be part of the academic elite (Crain et al., p. 4).

Extending the ideas of Crain and his colleagues to more general efforts to combine CTE and academic courses simply requires the following perspective. For students who do not see a four-year college degree as a definite desire or a certainly attainable goal, academic courses isolated from CTE exposure would be likely to seem irrelevant or frustrating. A student who did not feel sure that he or she would be able to enter a four-year college, or that he or she would want to enter a four-year college, would be likely to find limited meaning and excitement in studying solely core academic subjects. On the other hand, if academics were properly integrated with career-focused courses, such a student might see practical applications of the mathematics, science, reading, writing, and cultural studies contained within academic courses. Such a student with dual CTE and academic concentrations might apply greater effort to his or her academic studies than would that same student encountering only academic courses.

According to this perspective, a student's cognitive growth in the core academic subjects could be expected to be augmented when CTE and academic course-taking were featured jointly, as compared to when an academic concentration was featured alone. This might be especially the case for low-achieving students. Further, a student's general enthusiasm and attachment to high school could be expected to increase—and, thus, his or her risk of dropping out to decrease—when CTE and academic course-taking were coupled. These, of course, are hypotheses. They are hypotheses that have been investigated in some previous research (Boesel & McFarland, 1994; Boesel, Hudson, Deich, & Masten, 1994; Crain et al., 1999; Delci & Stern, 1999; Levesque et al., 2000; National Center for Education Statistics, 1999a; Rasinski & Pedlow, 1998), and they will be explored further in this report.

There are reasons to temper these hypotheses. Specifically, regarding effects on cognitive growth in academic subjects, some educators worry that combining CTE with an academic course load dilutes the quality and quantity of academic coverage. Indeed, the total number of courses students can take during their high school careers is limited. If CTE occupies a significant portion of a student's schedule, this limits the remaining hours available for core academic subjects. Thus, even if a dual CTE/academic concentration has motivational benefits that lead students to apply greater effort to academic courses, the limits that the dual concentration places on overall exposure to academic topics might have countervailing effects on achievement growth. Within this report, attention will be paid to these issues.

Another caveat that should be attached to the hypothesized benefits of a dual CTE/academic concentration involves the precise nature or character of an integrated curriculum. For any possible benefits to accrue, do the teachers of CTE and academic courses in an integrated program need to prepare lessons and teach in close collaboration with one another? Must mathematics and science teachers make explicit efforts to illustrate linkages between their subjects and career applications in order for potential motivational and achievement benefits to accrue? Must CTE teachers forge explicit connections to the academic subjects in their instruction for benefits to be realized? Or, will benefits be realized simply by exposing students to both types of course-taking, without radical changes in classroom practices or fundamental efforts at integrated planning and instruction? The questions posed in this paragraph are beyond the capacity of the data set. Crain et al. (1998, 1999) have offered some evidence suggesting that some benefits can be realized even without radical changes to classroom and school organization, and without much joint planning and integrated instruction. This initial evidence is important, and as future research is conducted on dual CTE/academic concentrations, more attention should be paid to these matters. Within the present report, however, there is much to analyze and summarize without even broaching these nuances.

RESEARCH QUESTIONS

Within the context of the multiple missions of high schools, diverse student populations, and evolving curricular organization, this study aims to increase our understanding of the relationship between (a) the balance struck between career and technical course-taking and academic course-taking during the high school years and (b) academic achievement, persistence in high school, and postsecondary destinations.

More specifically, this study addresses a series of interrelated questions for a nationally representative sample of public high school attendees who had been eighth graders in 1988. The study asks the following:

1. For this sample, what balance was struck between CTE and academic course-taking?
2. Can we detect effects of the balance between CTE and academic course-taking on achievement growth, as measured by standardized tests in the areas of mathematics, science, reading, and history?
3. Can we detect effects of the balance between CTE and academic course-taking on the likelihood of dropping out of high school (or, conversely, persisting in high school)?
4. Can we detect effects of the balance between CTE and academic course-taking on high school graduates' immediate postsecondary involvements?

DATA AND METHODS

The data for this study come from the National Education Longitudinal Study of 1988 (NELS:88), supported by the National Center for Education Statistics of the U.S. Department of Education. NELS:88 provides a rich source of information on adolescents and young adults as they progress through high school and into postsecondary education and the labor force. The NELS:88 base-year design employed a two-stage stratified random sample of approximately 25,000 eighth graders in more than 1,000 schools in 1988, who were then re-surveyed at two-year intervals through 1994 (Ingels, Abraham, Spencer, & Frankel, 1989; National Center for Education Statistics, 1996). In addition to student surveys and cognitive tests, the data base includes survey responses from parents, teachers, and school administrators. Also, of central importance to the present study, NELS:88 includes transcript data collected after the 1991–'92 school year, and covering all of a student's high school years.

In order to understand what the NELS:88 (hereafter identified simply as NELS) data can tell us about the effects of CTE and academic course-taking on high school persistence, academic achievement, and postsecondary destinations, it is important to note that most of the sample members graduated from high school in 1992. As such, their secondary school careers took place while the nature and quantity of vocational and college preparatory course-taking were still very much in transition in the United States. The 1990 Perkins Act, which encouraged a more integrated approach to CTE and college preparatory education, was probably just beginning to affect curricular organization. Legislation of the 1998 Perkins Act—which further encouraged the integrative approach—was still several years away. Thus, we should think of this longitudinal data set as one that can give us insights into trends and relationships as they existed in the earliest stages of the current wave of CTE reforms. Analyses of more recent data sets will be important as complements to studies such as the present one. The National Longitudinal Study of Youth 1997 promises to be one valuable source of comparisons, and analyses of vocational programs using that data set have begun (e.g., Delci & Stern, 1999). Other studies of these data are part of the current work of the National Research Center for Career and Technical Education.

In the present study, all analyses are limited to students who attended public high schools, because very little CTE course-taking was reported within the private high schools of the NELS sample. This data trend and sample selection decision is consistent with other recent studies of CTE experiences in U.S. high schools using nationally representative data. Analyses of 12^{th}-grade academic achievement are further limited to students who remained in school for four years of high school (and, correspondingly, had four years of transcript data available). This screening decision was due to the requirements of the variables used to indicate course-taking patterns, as will be described later in this report. Given this screening decision, it will be important to interpret any detected effects of CTE and academic course-taking upon test-score growth within the context of what course-taking patterns imply for the likelihood of dropping out.

Finally, analyses of postsecondary destinations are limited to individuals who had four years of transcript data available *and* had successfully completed high school by the end of 1992. (Most sample members graduated from high school in May or June of 1992.) As such, it will be important to interpret results of these models within the context of any selection effects upon the likelihood of successfully proceeding from eighth grade in 1988 to high school graduation in or before 1992.

All analyses are weighted by the NCES-provided longitudinal panel weights for students participating in the transcript component of NELS. The use of these weights allows for projections to the population of U.S. youth who were in the eighth grade in spring of 1988, subject to the caveats on sample screening provided in the preceding paragraphs.

Models of 1992 cognitive achievement are presented for the following subject areas: reading comprehension; mathematics; science; and history/citizenship/geography. The test battery was developed by the Educational Testing Service. For the 1992 data collection (the NELS second follow-up), multiple forms of the cognitive-test battery were produced, each comprising a different combination of mathematics and reading difficulty levels. Each sample member's test form was determined by his or her scores on the base year and/or first follow-up mathematics and reading tests. The analyzed scores are based on Item Response Theory. Additional details on the NELS cognitive tests, including the strategies employed to minimize ceiling and floor effects, are provided in Ingels et al. (1994) and Rock and Pollack (1995).

The models of cognitive achievement in each of the four subject areas utilize multiple ordinary least squares regression, which is appropriate given the continuous dependent variable and the fact that we must include numerous contextual variables as regressors in order to control for potentially confounding factors, as we focus on the effects of CTE and academic course-taking. In the tables that summarize the results of these models, unstandardized regression coefficients will be presented. These unstandardized coefficients reflect the number of test score points (or the portion of a test score point) that is added to, or subtracted from, an individual's predicted achievement level if a given independent variable increases by one unit, holding constant all other independent variables in the model.

The models of dropping out—which involve a nominal, dichotomous dependent variable and multiple independent variables—utilize logistic regression. Meanwhile, the models of postsecondary destinations use multinomial logistic regression to examine a nominal, five-category dependent variable as a function of a set of explanatory variables. In the tables that summarize the results of these models—both the models of dropping out and the models of postsecondary destinations—the estimated coefficients will reflect the additive effect of the independent variables on the log-odds $[\ln(p_i/p_j)]$ of an individual being in one status, i, rather than another, j. While this log-odds metric is necessary for the estimation of the models, it is admittedly a difficult metric to interpret. Therefore, the estimated parameters in the log-odds metric will be used primarily to identify which independent variables have statistically significant associations with the likelihood of dropping out of high school or with the likelihood of following one postsecondary path or another. More precise quantification and interpretation will be accomplished with reference to predicted probabilities, not predicted log-odds.

That is, the results in the log-odds metric will be used to highlight substantively important relationships. When we want to quantify and discuss the magnitude of these relationships more precisely, the appropriate mathematical transformations will be completed in order to translate predicted log-odds into predicted probabilities (p_i). Graphs will be utilized to display the predicted probability of a hypothetical individual (e.g., a white male, with average eighth-grade test scores and average socioeconomic status (SES), who fulfilled both CTE and academic concentrations during high school) ending up in each possible postsecondary outcome category (e.g., having a job during 1993 without being enrolled in an educational institution). To understand the origins of these graphs, the reader should keep in mind that the predicted probabilities will be based upon the estimated logistic regression, or multinomial logistic regression, models.

RESULTS

Distribution of course-taking

Before considering multivariate models of the three main outcomes to be studied, we should gain an understanding of the distribution of CTE and academic course-taking in the NELS sample. Table 1 is a cross-tabulation of whether or not an individual fulfilled a CTE concentration during high school, and whether or not he or she fulfilled an academic concentration. The definitions used here for CTE (or, interchangeably, vocational) concentration and academic concentration follow those used in a recent pair of reports from the U.S. Department of Education (National Center for Education Statistics, 1999b, 1999c). Specifically, in Table 1 and throughout this paper, a CTE concentration is defined as having earned at least 3 credits (Carnegie units) in a single Specific Labor Market Preparation (SLMP) vocational area.[1] These SLMP vocational areas are the following:

- agriculture and renewable resources;
- business;
- marketing and distribution;
- health care;
- public and protective services;
- trade and industry;
- technology and communications;
- personal and other services;
- food service and hospitality;
- child care and education; and
- unidentified subject (limited to course titles “Cooperative education 1,” “Vocational cooperative program,” “Cooperative training, diversified,” “Cooperative education 2,” and “Off-campus voc/tech training—unspecified”).

[1] Those readers familiar with the 1998 revision of the Secondary School Taxonomy may also know the SLMP vocational areas as the “2_C categories” (National Center for Education Statistics, 1999b, 1999c).

Table 1.
Cross-tabulation of academic concentration and CTE concentration, for public high school students with four years of transcript data

			CTE Concentrator		
			No	Yes	Total
Academic Concentrator	No, did not complete 4E+3SS+3S+3M	Frequency	3,985.	1,971.	5,956.
		Percent	38.29	18.94	57.23
		Row %	66.91	33.09	
		Col. %	51.17	75.25	
	Yes, did complete 4E+3SS+3S+3M	Frequency	3,804.	648.	4,452.
		Percent	36.54	6.23	42.77
		Row %	85.44	14.56	
		Col. %	48.83	24.75	
	Total	Frequency	7,789	2,619	10,408
		Percent	74.84	25.16	100.00

Note: E = English, SS = Social Studies, S = Science, M = Mathematics

An academic concentration is defined as having fulfilled a somewhat lenient version of the *New Basics* (four Carnegie units of English and three Carnegie units each of mathematics, science, and social studies).[2] These definitions of CTE and academic concentrations have a basis in previous educational writing and research. The concept of the New Basics was first articulated in the influential report *A Nation at Risk* (National Commission on Excellence in Education, 1983). The New Basics have subsequently had a strong influence on high school curricular policies and have been the subject of some research (e.g., Alexander & Pallas, 1984).

Note that Table 1 includes only public high school students, and only those sample members for whom four years of transcript data were available. The thresholds defined for CTE and academic concentrations are levels that generally will be reached only cumulatively, over an entire high school career. Thus, neither dropouts nor sample members with incomplete transcript data are represented in Table 1. In fact, for the analyses of dropping out later in this report, we will need to utilize a different technique to represent the balance of CTE and academic course-taking.

Table 1 shows that, of 10,408 weighted cases, 38.29% had completed neither a CTE concentration nor an academic concentration during four years of high school. Supplemental analyses (not shown here) confirm that all of these individuals completed some courses in the core academic areas, and some of these individuals completed some CTE courses, but neither of the thresholds defining concentrations was met.

[2] This is called a “somewhat lenient version” of the New Basics, because descriptions of the New Basics sometimes include requirements for computer studies and foreign language, in addition to English, mathematics, science, and social studies.

Just under 19% of the sample members (*n*=1,971) completed a CTE concentration, but not an academic concentration. A larger group (36.54% of the sample) fulfilled an academic concentration, but not a CTE concentration. Finally, a relatively small group (6.23% of the sample)—but one that is very important to our analyses—fulfilled both CTE and academic concentrations. This distribution of cases across the four cells of Table 1 is generally consistent with patterns reported elsewhere—based on both NELS and other nationally representative samples—for U.S. high school students in the first half of the 1990s (Levesque et al., 2000; National Center for Education Statistics, 1999a).

Table 2 summarizes eighth-grade achievement levels, gender and racial composition, and socioeconomic status (SES) for students in each of the four categories established in Table 1.[3] (The four columns of Table 2 correspond to the four cells of Table 1.) Across the four subject areas tested in eighth grade (mathematics, science, reading, and history), a consistent pattern is revealed. That is, those who would become purely academic concentrators in high school consistently scored the highest on the eighth-grade tests, followed by those who would be dual concentrators, followed by those who would concentrate in neither area. Finally, the purely CTE concentrators had the lowest average test scores in each subject area. These differences in pre-high school achievement levels alert us to the fact that prior achievement should be controlled statistically in our predictive models of high school achievement and persistence. Similarly, the four groups differ enough in terms of gender composition, racial composition, and socioeconomic status to require that we control for these variables in our multivariate models.

[3] The variable measuring socioeconomic status is a composite of parents' education, parents' occupational prestige, and family income. It is named "F2SES1" in the NELS database. Details on its construction can be found in "Appendix H" of Ingels et al. (1994).

Table 2.
Mean eighth-grade test scores, gender composition, racial composition, and socioeconomic status, by cross-classification of CTE concentration and academic concentration, for public high school students with four years of transcript data

	CTE (no), Acad (no)	CTE (yes), Acad (no)	CTE (no), Acad (yes)	CTE (yes), Acad (yes)
Eighth-grade mathematics test	34.3	31.7	41.5	37.9
Eighth-grade science test	18.4	17.2	20.7	19.6
Eighth-grade reading test	26.2	23.6	30.7	27.4
Eighth-grade history test	29.2	28.0	31.4	30.0
Male	0.48	0.58	0.46	0.55
Asian	0.033	0.026	0.048	0.029
Hispanic	0.116	0.111	0.075	0.076
Black	0.120	0.123	0.112	0.116
Native American	0.012	0.013	0.006	0.011
White or other	0.719	0.728	0.760	0.768
SES	-0.080	-0.306	0.254	-0.056

(*n* = 10,408)

1992 test performance

We begin our examination of the multivariate models by considering 1992 test performance in four core academic subject areas. Tables 3 through 6 show estimated regression coefficients for models of 1992 achievement on standardized tests of mathematics, science, reading, and history, respectively. Each table summarizes four estimated models which add predictors successively, building to the final models (Model 3D in Table 3, Model 4D in Table 4, Model 5D in Table 5, Model 6D in Table 6). Each table's Model A includes just an intercept and a prior test score from eighth grade. Each Model B adds dummy variables indicating gender and race/ethnicity. Each Model C adds socioeconomic status as a predictor. Having entered these background controls, each of which has quite consistently proven to be correlated with academic achievement in the cumulative body of education research and in these models of Tables 3 through 6, we can focus on the effects of CTE and academic course-taking in each Model D.

Table 3.
OLS regression models of 1992 mathematics achievement

	Model			
	3A	3B	3C	3D
Intercept	13.31***	14.07***	15.18***	19.52***
Eighth-grade math test	0.96***	0.94***	0.91***	0.86***
Male		0.86***	0.78***	1.14***
Asian		2.05***	2.00***	1.71***
Hispanic		-1.10***	-0.31	-0.56
Black		-2.74***	-2.26***	-2.75***
Native American		-2.74**	-2.31**	-2.23**
SES			1.56***	1.01***
CTE (no), Acad (no)				-3.77***
CTE (yes), Acad (no)				-5.71***
CTE (yes), Acad (yes)				-0.91**
Adjusted R^2	0.671	0.677	0.683	0.706

* *p* < .05   ** *p* < .01   *** *p* < .001
(*n* = 8,570)

Table 4.
OLS regression models of 1992 science achievement

	Model			
	4A	4B	4C	4D
Intercept	6.25***	7.38***	8.11***	9.80***
Eighth-grade science test	0.90***	0.84***	0.80***	0.76***
Male		1.13***	1.12***	1.28***
Asian		0.03	-0.04	-0.19
Hispanic		-1.40***	-0.80***	-0.89***
Black		-2.74***	-2.34***	-2.52***
Native American		-1.98***	-1.61***	-1.57***
SES			1.10***	0.87***
CTE (no), Acad (no)				-1.44***
CTE (yes), Acad (no)				-1.99***
CTE (yes), Acad (yes)				-0.60**
Adjusted R^2	0.494	0.524	0.539	0.554

* $p < .05$ ** $p < .01$ *** $p < .001$
($n = 8{,}511$)

Table 5.
OLS regression models of 1992 reading achievement

	Model			
	5A	5B	5C	5D
Intercept	10.67***	12.23***	12.99***	15.04***
Eighth-grade reading test	0.83***	0.80***	0.77***	0.73***
Male		-0.67***	-0.79***	-0.67***
Asian		1.14**	1.05**	0.84*
Hispanic		-1.02***	-0.43	-0.57*
Black		-2.80***	-2.40***	-2.61***
Native American		-2.47**	-2.14**	-2.10**
SES			1.12***	0.82***
CTE (no), Acad (no)				-1.61***
CTE (yes), Acad (no)				-2.99***
CTE (yes), Acad (yes)				-0.62*
Adjusted R^2	0.514	0.524	0.530	0.540

* $p < .05$ ** $p < .01$ *** $p < .001$
(n = 8,569)

Table 6.
OLS regression models of 1992 history achievement

	Model			
	6A	6B	6C	6D
Intercept	11.20***	12.24***	13.35***	15.10***
Eighth-grade history test	0.80***	0.77***	0.73***	0.69***
Male		0.25**	0.25**	0.40***
Asian		0.31	0.25	0.12
Hispanic		-0.92***	-0.42**	-0.50***
Black		-1.75***	-1.39***	-1.49***
Native American		-1.52***	-1.26**	-1.25**
SES			0.89***	0.70***
CTE (no), Acad (no)				-1.08***
CTE (yes), Acad (no)				-1.82***
CTE (yes), Acad (yes)				-0.65***
Adjusted R^2	0.465	0.478	0.492	0.507

* $p < .05$ ** $p < .01$ *** $p < .001$
($n = 8{,}452$)

Three dummy variables and an excluded reference category are used to indicate an individual's balance of CTE and academic course-taking. The first of these dummy variables included in the models is "CTE (no), Acad (no)," which takes the value "1" if an individual fulfilled neither concentration; it takes the value "0" otherwise. The second dummy variable is "CTE (yes), Acad (no)," which takes the value "1" for individuals who were purely CTE concentrators; it takes the value "0" otherwise. Finally, the third dummy variable is "CTE (yes), Acad (yes)," which equals "1" for dual concentrators and equals "0" otherwise. The excluded reference category represents purely academic concentrators.

For each of the four subject areas (in each of Tables 3 through 6), the block of three dummy variables improves the fit or explanatory power of the model, as measured by improvements in adjusted R^2 statistics. Over and above the background control measures introduced in the earlier models, the course-taking indicators of each Model D have significant associations with student achievement. While these models are not growth models, *per se*, they are models of 1992 achievement that control for 1988 achievement. Thus, we can interpret the coefficients as estimated differences in 1992 achievement for two hypothetical individuals who shared the same pre-high-school achievement levels, gender, race, and SES, but who differed in their high school course-taking trajectories.

For each of four subject areas, the rank ordering of the four course-taking categories B in terms of estimated effects on achievement B is the same. Specifically, the purely academic concentrators are estimated to show the highest achievement. Significantly behind this group, but ranked second, are the dual concentrators. Ranked third is the group that fulfilled neither concentration. The lowest-ranked group, in terms of estimated achievement, is the group of purely CTE concentrators.

To illustrate the case of mathematics, parameter estimates in the final column of Table 3 reveal that dual concentrators are estimated to score 0.91 points behind the purely academic concentrators. Those who fulfilled neither concentration are estimated to score 3.77 points behind the purely academic concentrators (and 2.86 points behind the dual concentrators, which is not shown in the table but can be computed directly from the tabulated coefficients). The purely CTE concentrators are estimated to score 5.71 points behind the academic concentrators, 4.80 points behind the dual concentrators, and 1.94 points behind those who fulfilled neither concentration. To reiterate, these effects of course-taking patterns are estimated after controlling for 1988 test performance and the other variables in the models.

The asterisks indicating significance levels show that each of the three course-taking statuses represented by the included dummy variables ranks significantly behind the academic concentrators. Results of additional *t*-tests (not shown) confirm that every pair of statuses is significantly differentiated in these models for each of the subject areas. In reporting these significance levels, it is important to compare the findings with results reported in the recent report by Levesque et al. (2000). Those analysts presented descriptive tables that compared mean growth in mathematics and reading between 1988 and 1992 for various subgroups derived from this same NELS data set. They used a course-taking categorization of (a) college preparatory only, (b) vocational concentration only, (c) both vocational concentration and college preparatory, and (d) other/general that very nearly corresponds to the categorization used in this report's models. For gains between 1988 and 1992, they found the same rank ordering among the course-taking categories that is being reported here. However, their comparisons of subgroup means showed that the differences between the college preparatory group and the dual concentrators were statistically insignificant, or indistinguishable.

It appears that the discrepancy in significance levels between the two analyses has to do with the difference between estimating multiple regression models and comparing subgroup means in descriptive tables. With a sample as large as we have available in the present analyses, even fairly small regression coefficients can prove to be statistically significant. In addition to assessing statistical significance, then, one should consider substantive significance.

Appendix Table A1 shows descriptive statistics for the variables and samples of Tables 3 through 6. From this appendix table, we can see that 1992 mathematics achievement for this sample had a mean of 48.953 and a standard deviation of 13.688. In light of these facts, what should we make of the estimated difference between the academic concentrators and the dual concentrators of 0.91 test score points? Well, at some level the difference simply is what it is; 0.91 divided by 13.688 is about 0.07, which would generally be deemed a fairly modest effect. For each of the other subject areas, this version of an effect size is of a similar magnitude. It seems sensible to conclude that the dual concentrators definitely lagged behind the purely academic concentrators in achievement growth, but not by especially large margins.

What might explain this advantage for the academic concentrators, and the differences among the four course-taking trajectories more generally? A small part of the explanation may be revealed by Table 7. This table shows mean Carnegie credits earned in various curricular areas during the high school career for students from each of the four course-taking categories. In this table, higher mathematics includes geometry, algebra 2 through pre-calculus, and courses classified as advanced mathematics (calculus, AP/IB courses, and a few other courses including SAT review, actuarial sciences, and matrix algebra).[4] Higher science includes regular, advanced, honors, and specialized courses in biological sciences; regular, advanced, honors, and specialized courses in chemistry; and regular, advanced, honors, and specialized courses in physics.[5]

[4] These courses classified as "higher mathematics" are those listed in the 1998 revision of the Secondary School Taxonomy under 1_15, 1_16, and 1_17 (National Center for Education Statistics, 1999c).

[5] These courses classified as "higher science" are those listed in the 1998 revision of the Secondary School Taxonomy under 1_22B, 1_22C, 1_22D, 1_23B, 1_23C, 1_23D, 1_24B, 1_24C, and 1_24D (National Center for Education Statistics, 1999c).

Table 7.
Mean course credits in various areas during high school career, by cross-classification of CTE concentration and academic concentration, for public high school students with four years of transcript data

	CTE (no), Acad (no)	CTE (yes), Acad (no)	CTE (no), Acad (yes)	CTE (yes), Acad (yes)
All mathematics	2.9	2.6	3.8	3.7
Higher mathematics	1.2	0.7	2.5	2.1
All science	2.4	2.1	3.7	3.6
Higher science	1.4	1.0	2.6	2.2
English	4.0	4.0	4.4	4.4
Social Studies	3.4	3.1	3.8	3.6
CTE	3.4	7.0	2.4	6.5

(n = 10,408)

From Table 7, one can see that the purely academic concentrators and the dual concentrators were fairly similar in the amount of total mathematics, total science, English, and social studies they completed during their high school years, on average. For each of these subject groupings, the means for the academic concentrators and dual concentrators are within 0.2 Carnegie units of one another. In higher mathematics and higher science, however, the academic concentrators distanced themselves from the dual concentrators slightly more. In higher mathematics, for example, the academic concentrators completed 2.5 Carnegie units, on average, during their high school careers while the dual concentrators completed only 2.1 credits. This difference of just under a semester's worth of higher mathematics course-taking may begin to explain the differential achievement effects estimated in Table 3.

As we examine Table 7, we should understand a likely reason for the discrepancy in higher mathematics and higher science credits: The dual concentrators were (partly, by definition) completing much more CTE course-taking during their high school careers than were the academic concentrators. The dual concentrators completed 6.5 units of career and technical education while the academic concentrators completed only 2.4 units of CTE. Given the finite amount of time in a student's course schedule each semester, the relatively high levels of CTE course-taking among dual concentrators would have necessarily cut into some other potential course-taking. Apparently, for many of these dual concentrators, advanced topics in mathematics and science are a part of what received diminished priority.

To summarize the analyses of 1992 test performance in the four core academic subjects, there is a small but statistically significant effect of choosing to pursue two concentrations in high school. Even if there are some motivational benefits associated with a dual concentration for some students, the zero-sum nature of time in a student's course-taking schedule may partially explain the fact that purely academic concentrators exhibited higher 1992 achievement levels—controlling for 1988 achievement—than did dual concentrators. Additionally, there may be other important differences in the nature and quality of instruction for the two groups that have not been explicitly modeled in these analyses as well as other unmeasured differences between these students. Any such differences merit future research attention.

Dropping out of high school

Table 8 summarizes logistic regression models of the log-odds of dropping out of high school prior to graduation (at any point between March 1989, and spring 1992). Appendix Table A2 shows descriptive statistics for the variables and cases of Table 8. That appendix table shows that, overall, 12.28 percent of this public school sample dropped out of high school at some point. (Some of these dropouts later returned to pursue high school completion; this dependent variable literally measures whether the individual "ever dropped out" between 1989 and 1992.)

Similar to what was presented for 1992 test scores, a series of models is built successively across the columns of Table 8, culminating in the final Model 8F. The preliminary models introduce an intercept, dummy variables for gender and race/ethnicity, a measure of SES, an eighth-grade test score composite measure, and high school grade point average. Grade point average is calculated from transcript data and, in the case of dropouts, is calculated based on grades earned during the time the individual was enrolled in high school.

Two variables—different from the dummy variables used in Tables 3 through 6—capture an aspect of the balance between CTE and academic course-taking for the models of Table 8. In Model 8E, the ratio of CTE credits earned to academic credits earned is entered as a predictor.[6] For this particular analysis, this predictor is preferable to a series of dummy variables such as those used in Tables 3 through 6 because of censoring issues. As was stated earlier, the thresholds defined for CTE and academic concentrations in the models of academic achievement are levels that generally could be reached only cumulatively, over an entire high school career. For dropouts, the high school career is by definition truncated before graduation. Thus, we would expect few or no dropouts to have exceeded the New Basics threshold or, most likely, the CTE concentration threshold. The use of the CTE/academic ratio is intended as a solution to the censoring problem. Regardless of how many high school semesters a student completed—perhaps 2 or 4 or 5 for an eventual dropout, generally 8 for an on-pace graduate—the ratio of CTE credits to academic credits can be calculated.

[6] In constructing this CTE/academic ratio variable, CTE courses include all courses listed under 2_A, 2_B, and 2_C in the 1998 revision of the Secondary School Taxonomy. Academic courses include all mathematics, science, English, and social studies (including history) courses; these are all courses listed under 1_1, 1_2, 1_3, and 1_4 in the 1998 revision of the Secondary School Taxonomy (National Center for Education Statistics, 1999c).

Table 8.
Maximum likelihood estimates of effects on log-odds of dropping out of high school

	Model					
	8A	8B	8C	8D	8E	8F
Intercept	-1.97***	-1.99***	-2.11***	1.98***	3.19***	3.62***
Male		-0.13*	-0.09	-0.57***	-0.57***	-0.58***
Asian		-0.43*	-0.46*	-0.08	-0.19	-0.20
Hispanic		0.49***	-0.09	-0.31**	-0.46***	-0.45***
Black		0.22**	-0.23*	-0.85***	-1.05***	-1.06***
Native American		0.88***	0.44	-0.07	-0.28	-0.30
SES			-0.93***	-0.59***	-0.69***	-0.70***
Eighth-grade tests				-0.02***	-0.03***	-0.03***
High school g.p.a.				-1.83***	-1.91***	-1.89***
CTE/Acad ratio					-2.06***	-4.57***
$(\text{CTE/Acad ratio})^2$						2.97***
-2 log-likelihood	8415.47	8354.79	7862.48	6434.93	6243.92	6203.90
Improvement in chi-squared		60.67	552.99	1980.54	2171.55	2211.57
Degrees of freedom		5	6	8	9	10
Percent concordant		44.4	68.1	84.4	85.1	85.2
c statistic		.569	.685	.846	.852	.854

* $p < .05$ ** $p < .01$ *** $p < .001$ ($n = 11{,}352$)

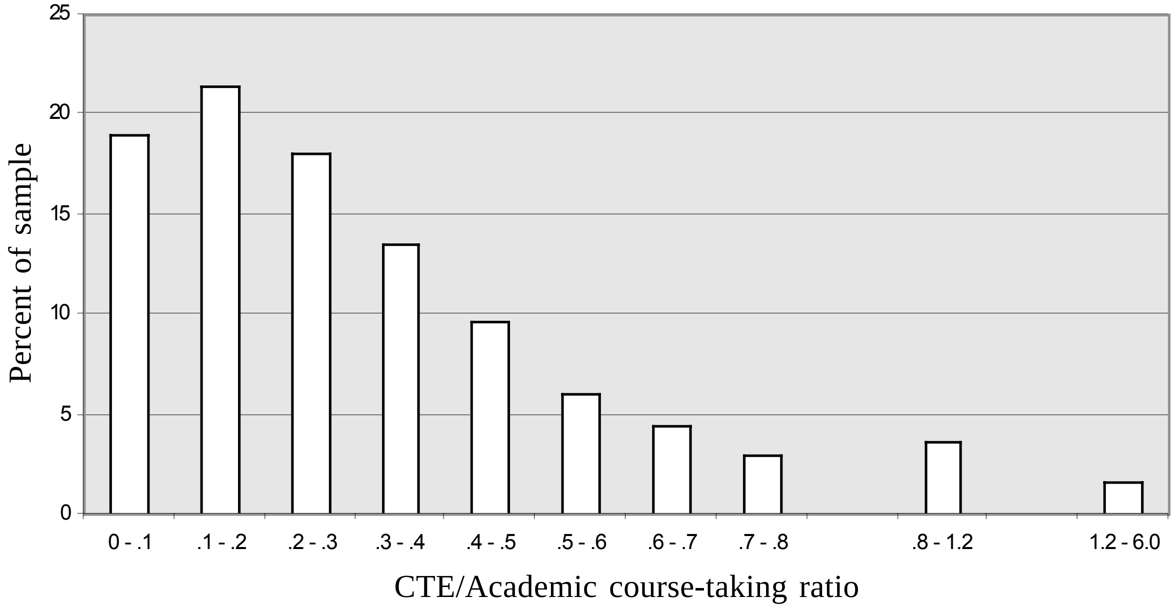


Figure 1. Distribution of CTE/Academic course-taking ratio, for public-high-school students including dropouts (n =12,303).

The research question of interest is this: Is there a significant relationship between this CTE/academic ratio and an individual's likelihood of dropping out? Figure 1 shows the distribution of CTE/academic ratio levels for this sample. The histogram illustrates that just under 19% of the sample had ratios between 0 and 0.1. Another 21.36 percent had ratios between 0.1 and 0.2. Cumulatively, 81.61% had ratios somewhere below 0.5, which is the point at which an individual is taking one CTE course for every two academic courses.

Figure 1 is presented partly to illustrate the small but noteworthy number of cases in the right-hand tail of the distribution. Approximately 1.6 percent of the cases have ratios between 1.2 and 6.0. A more detailed examination of the distribution suggested that, substantively and empirically, a distinct breakpoint exists in the data somewhere around 1.2. Cases with ratios above this level are truly special cases. These are probably either individuals in very specialized vocational academies or individuals with transcript data of questionable accuracy. In either case, their extreme values on this important explanatory variable give these cases the potential to have undue influence on model estimation. It is probably best to eliminate them from the analyses.

Accordingly, the analyses of Table 8 are limited to cases with CTE/academic ratios between 0 and 1.2. Interpretations of the model estimations should not be extended to cases with values above 1.2. Even at levels between 0.8 and 1.2, we should make inferences with some caution due to the sparseness of the data in this range.

Let us return more directly to the estimated models of Table 8. By entering the CTE/academic ratio as a first-order effect in Model 8E, we are testing whether there is a linear relationship (whether positive or negative in sign) between the CTE/academic ratio and the log-odds of dropping out.[7] And, in fact, a negative and significant relationship is estimated. (See coefficient of -2.06.) Model 8E does offer a significant improvement in fit over each Models 8A through 8D. The substantive implication of Model 8E is that, if we constrain the relationship between the CTE/academic course-taking ratio and the log-odds of dropping out to be linear, a greater representation of CTE courses in an individual's high school experience reduces the likelihood of dropping out. This finding is tentative support for the idea that a coupling of career-related courses with an academic load may increase a student's commitment or attachment to high school.

Before we go too far with this interpretation, however, we should consider Model 8F. In this model a squared term is added as a predictor. This polynomial functional form allows us to investigate whether a significant curvilinear relationship exists between the CTE/academic ratio and dropping out. With this functional form, we can ask: Is too much CTE too much of a good thing? Is there a point of inflection, after which the risk of dropping out begins to rise?

Model 8F suggests that indeed there is a significant curvilinear relationship between the probability of dropping out and the ratio of CTE credits to academic credits. Specifically, controlling for prior achievement, grades, and student background characteristics, a student's probability of dropping out appears to be lowest when approximately 3 Carnegie units of CTE is completed for every 4 Carnegie units of academic subjects. That is, the point of inflection for this polynomial function comes when the CTE/academic ratio is about 0.77. This is the point at which the risk of dropping out is estimated to be at its lowest.

To help us visualize the nature and magnitude of this effect, Figure 2 depicts predicted log-odds of dropping out for three hypothetical sets of students, as the CTE/academic ratio ranges

[7] There are interesting and important findings regarding gender, race, and SES in the models that precede Model 8E. Some of these findings are best understood by reading across the models of Table 8. Most notable, perhaps, is the way black and Hispanic students are shown to be significantly more likely to drop out than white students in Model 8B, but then significantly less likely to drop out than white students in later models. The change in direction of association appears and becomes more pronounced as SES, prior achievement, and high school gpa are introduced in succession. A likely explanation, or interpretation, of the changes across successive models is that the high dropout rates observed among black and Hispanic students in the sample, before controlling for various background characteristics, are the relatively low levels of SES and scholastic achievement that characterize these groups on average. Their low levels of SES and achievement place them at relatively high risk for dropping out. If we compare black, Hispanic, and white students at common (shared) levels of SES and scholastic achievement, however, the black and Hispanic students are at lower risk than their white counterparts for dropping out. On one hand, this interpretation highlights a distressing situation for black and Hispanic students, as their lesser socioeconomic resources and educational disadvantages have serious consequences for their life-course trajectories. On the other hand, this interpretation also could prompt one to ask about positive messages or influences regarding persistence in school being received by black and Hispanic students of a given socioeconomic status and achievement level, relative to white students of the same SES and achievement level. These interesting and important findings are not given further attention here, in the interest of paper length and focus, but they certainly merit future investigation.

from 0 to 1.2. All three curves in the figure are plotted using the estimated coefficients of Model 8F, and for white males of average SES. Distinguishing the curves beyond those commonalities, however, are the facts that the top curve plots estimates for individuals whose eighth-grade test scores and high school grade point average were both one standard deviation below the sample's grand means. The middle curve plots estimates for individuals who were at the sample means for test scores and grade point average. The lowest curve represents individuals whose tests and grade point average were one standard deviation above the grand means.

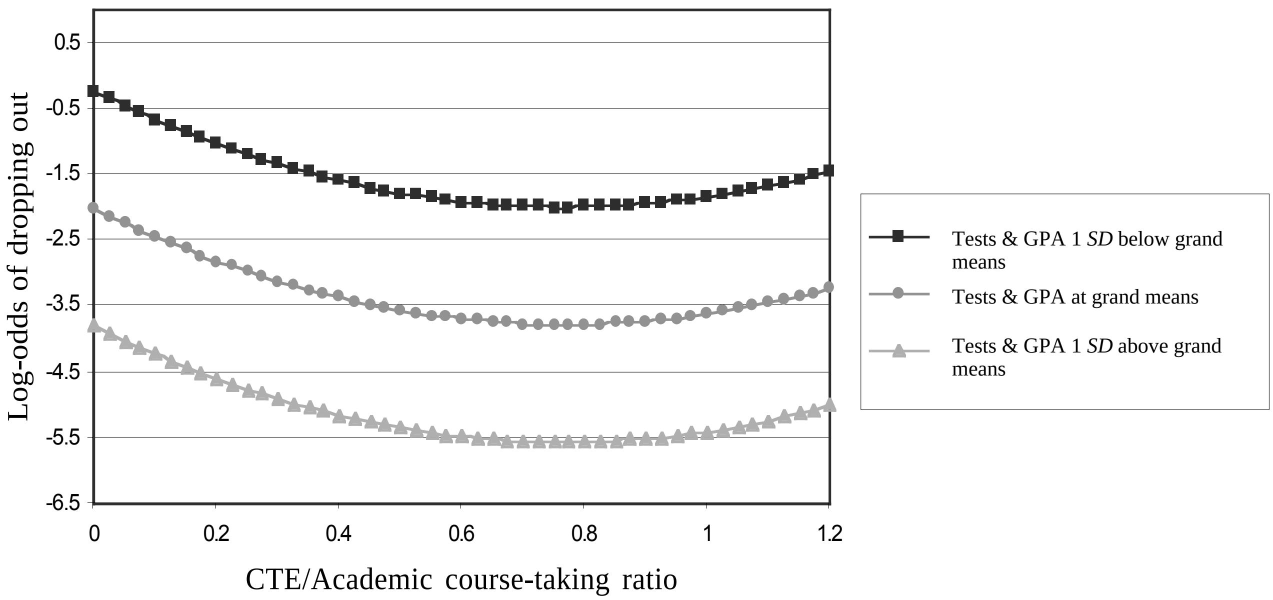


Figure 2. Predicted Log-Odds of Dropping Out, as "CTE/Academic course-taking ratio" varies, for a white male of average family SES

The fact that the individuals with above-average tests and grade point averages have the lowest log-odds of dropping out (the most negative log-odds) reflects the fact that higher test scores and grades provide a buffer against the risk of dropping out. The shapes of the three curves in Figure 2 are the same. What differs are their orientations along the vertical axis. These differences are driven by their differing test scores and grades. Movement up or down the CTE/academic ratio scale affects all three hypothetical populations equally in terms of log-odds.

In terms of estimated probabilities of dropping out, however, a more complex and intriguing pattern exists. Figure 3 presents predicted probabilities of dropping out for the same hypothetical populations as were depicted in Figure 2 and across the same range of CTE/academic ratios. Again, the plotted curves of Figure 3 are derived from the parameter estimates of Model 8F, with appropriate mathematical transformations completed to express outcomes in terms of probabilities rather than log-odds.

Figure 3 reflects the fact that a fixed change in the CTE/academic ratio has a greater effect on the probability of dropping out when we are considering a set of individuals whose other risk factors place their overall probability of dropping out near the middle of its possible range (approaching 0.5) rather than near 0 or 1 (Agresti, 1990, p. 84). This fact is inherent in the properties of logistic regression and does not represent an interaction term, *per se*, as some might be tempted to claim. For example, we are not witnessing an interaction between the CTE/academic ratio and grade point average as these variables affect the log-odds of dropping out. Rather, we are witnessing the fact that a unit change in the log-odds of dropping out implies a greater change in the probability of dropping out when the probability of dropping out is near the middle of its possible range rather than being near 0 or 1.

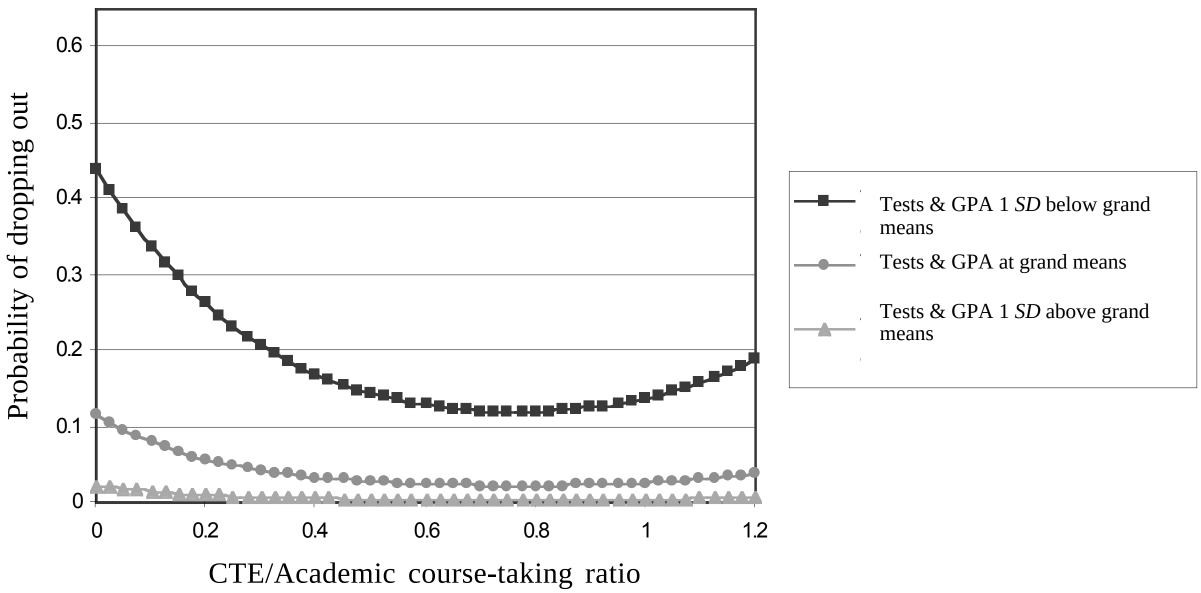


Figure 3. Predicted Probability of Dropping Out, as "CTE/Academic course-taking ratio" varies, for a white male of average family SES

Let us not get lost in these methodological details, however, but instead let us focus on the substantive implications of Model 8F, and Figures 2 and 3. Substantively, the estimated model implies that there is a healthy middle-range mix of CTE and academic course-taking that may maximize students' attachment and perseverance in high school. The implications of this curvilinear trend are most salient for students who are already at relatively high risk of dropping out (due to low prior test scores or low grades, for example). For these students, especially, it may be that a high school experience that is purely academic presents them with courses that do not seem highly relevant to their goals or worldviews. Further it is possible (but not investigated in the present analyses) that a high school experience that is purely academic but aimed at students whose achievement levels place them at low or middle-range levels may be characterized by unengaging, watered-down versions of more challenging and inspiring courses offered to higher-achieving students.

If the preceding paragraph offers possible explanations for the left-hand part of the curvilinear function (for CTE/academic ratios between 0 and 0.77), how might we explain the estimated effects for the right-hand part of the function (as CTE/academic ratios grow beyond 0.77)? As we approach this other end of the CTE/academic ratio distribution, it appears that a high school experience that tips too far toward career and technical education, to the exclusion of a solid academic grounding, also increases the risk of dropping out. We can speculate that this finding might be due to educational experiences that are relegating students to the periphery of the high school's culture and mission. Further investigations are warranted to discover more about why a certain middle-range mix of CTE and academic course-taking may minimize the frequency of students dropping out.

Postsecondary status in 1993

The previous sections have examined the associations of course-taking patterns with (a) student achievement, and (b) the likelihood of dropping out. In addition to these outcomes, it is informative to examine individuals' postsecondary trajectories.

Table 9 presents a multinomial logistic regression model of sample members' employment and educational statuses during 1993 (the first full calendar year after high school graduation for most of these individuals). Each individual in the sample can be identified as being in one and only one of the following five categories in 1993:

1. Did not enroll in any postsecondary educational institution, held no job;
2. Enrolled, held no job;
3. Did not enroll, held job(s);
4. Enrolled, held job(s), defined oneself as "primarily a student;" or
5. Enrolled, held job(s), defined oneself as "primarily a worker."

The columns of Table 9 show the effects of independent variables on the log-odds of being in the fourth category, above, rather than each of the other four. For example, the first column of estimated parameters concerns the log-odds of an individual (a) not enrolling in a postsecondary educational institution and not holding any job during 1993, rather than (b) enrolling, holding a job, and defining oneself primarily as a student. The second, third, and fourth columns of estimated parameters concern the log-odds of holding the other statuses relative to enrolling, holding a job, and defining oneself primarily as a student.

Table 9.
Maximum likelihood estimates of effects on log-odds of holding one postsecondary status during 1993 versus another status

	Contrast			
	Not enrolled, Held no job vs. Enrolled, held job(s), primarily student	Enrolled, Held no job vs. Enrolled, held job(s), primarily student	Not enrolled, held job(s) vs. Enrolled, held job(s), primarily student	Enrolled, held job(s), primarily worker vs. Enrolled, held job(s), primarily student
Intercept	-0.557	-1.092***	1.585***	0.864***
Male	-0.083	-0.103	0.477***	0.099
Asian	0.065	0.561**	-0.743***	-0.775**
Hispanic	-0.149	0.342*	-0.843***	-0.230
Black	0.142	0.522***	-0.533***	-0.416**
Native American	1.029	0.282	-0.039	0.022
SES	-1.090***	0.008	-1.038***	-0.274***
Eighth-grade tests	-0.066***	-0.010*	-0.069***	-0.045***
CTE (no), Acad (no)	1.030***	-0.186	1.213***	0.576***
CTE (yes), Acad (no)	1.699***	-0.391*	1.828***	0.871***
CTE (yes), Acad (yes)	0.212	-0.181	0.689***	0.432**

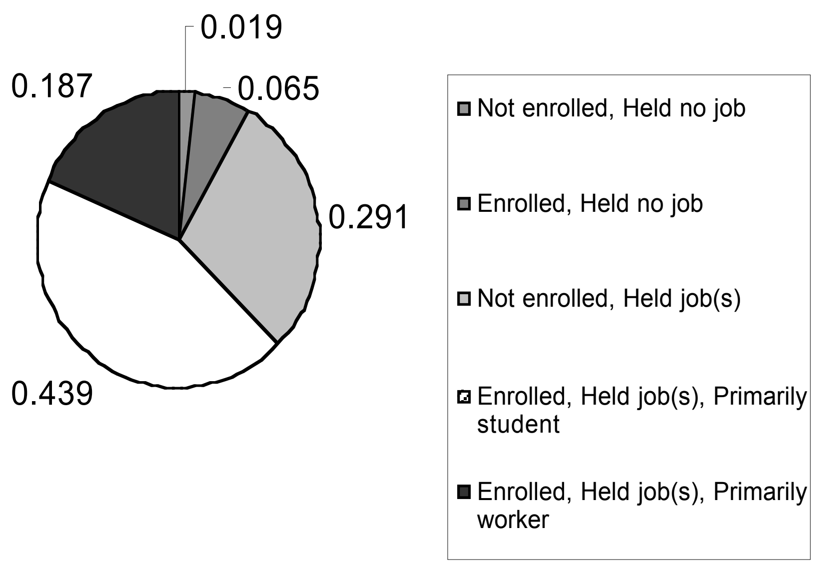
* $p < .05$ ** $p < .01$ *** $p < .001$
($n = 7{,}207$)

The model of Table 9 again utilizes the distinctions of whether or not an individual fulfilled a CTE concentration during high school and whether or not he/she fulfilled an academic concentration during high school. The table contains a lot of information, but for our purposes we can focus on the question of whether differences in course-taking patterns during high school—controlling for gender, race/ethnicity, SES, and pre-high school test scores—are associated with differences in individuals' likelihoods of following one or another postsecondary trajectory.

The model controls for pre-high school test scores but not for high school grades or test scores in order to capture what is arguably the full effect of high school course-taking patterns. As Tables 3 through 6 showed, high school course-taking patterns do appear to affect high school achievement. And, thus, any effects of high school achievement that might be detected in determining postsecondary destinations are partly attributable to course-taking. Following this logic, if we are interested in revealing the full (total) effects of course-taking on postsecondary destinations, we should not include high school grades or test scores as independent variables. We can think of the model of Table 9 as controlling for achievement inputs to the high school experience, but not achievement outputs.

The bottom three rows of Table 9 contain many significant effects associated with course-taking patterns. To aid us in visualizing these estimated effects, Figures 4A through 4D use the parameter estimates of Table 9 to portray the predicted probabilities of four hypothetical individuals reaching each of the 1993 statuses. All four figures depict white males who match the sample means for SES and eighth-grade test scores. The four figures differ from one another in that Figure 4A depicts an individual who fulfilled neither a CTE nor an academic concentration; Figure 4B depicts an individual who was a CTE concentrator but not an academic concentrator; Figure 4C depicts a purely academic concentrator; and Figure 4D depicts a dual concentrator.

Figure 4A. Predicted probabilities of 1993 status for one who fulfilled neither CTE nor Academic concentrations



Note: Predicted probabilities for each figure are based on the model summarized in Table 9. They are calculated for white males who match the sample mean for socioeconomic status and eighth-grade test scores. The four figures differ in the course-taking sequences of the four hypothetical individuals.

Figure 4B. Predicted probabilities of 1993 status for one who fulfilled CTE but not Academic concentration

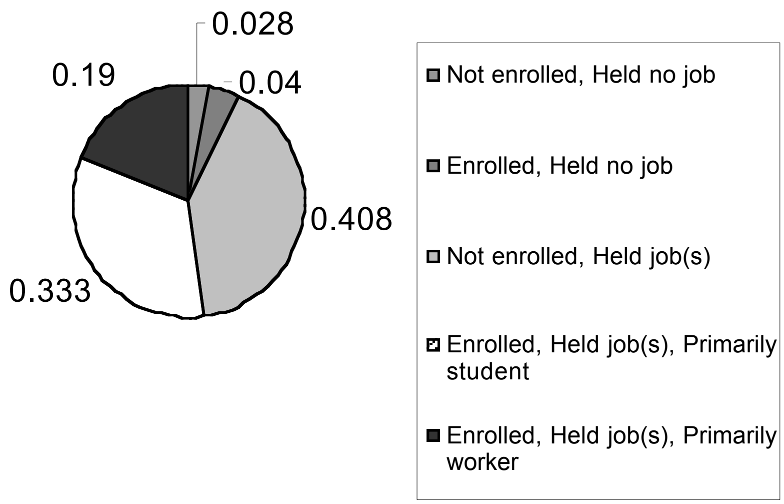
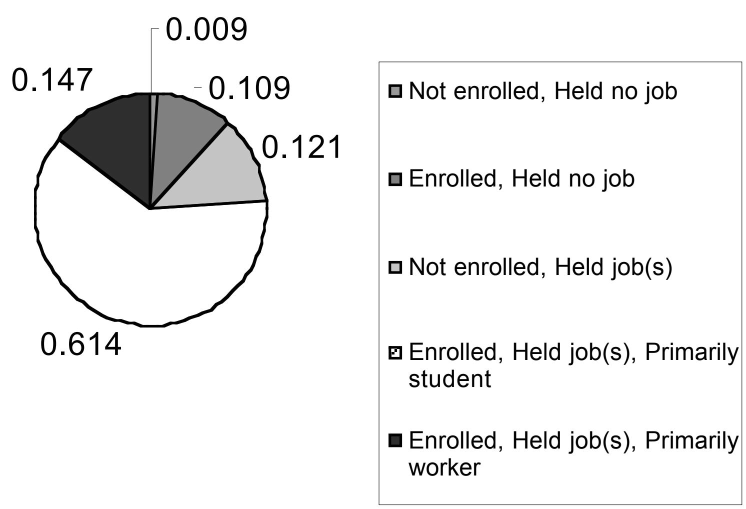
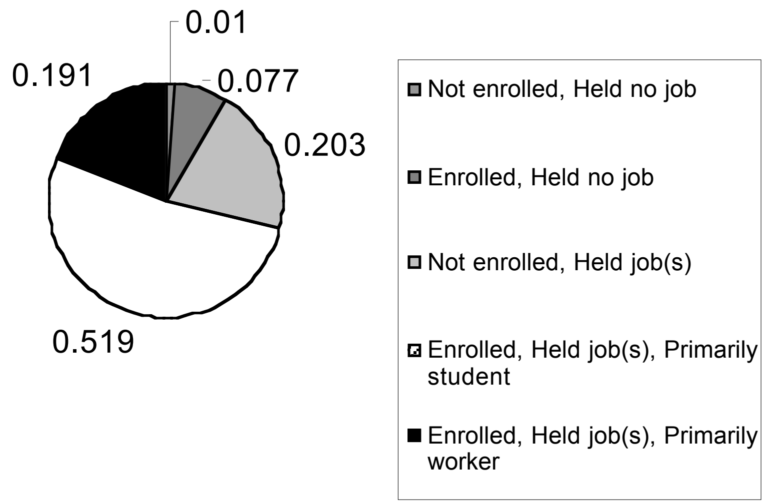


Figure 4C. Predicted probabilities of 1993 status for one who fulfilled Academic but not CTE concentration



Note: Predicted probabilities for each figure are based on the model summarized in Table 9. They are calculated for white males who match the sample mean for socioeconomic status and eighth-grade test scores. The four figures differ in the course-taking sequences of the four hypothetical individuals.

Figure 4D. Predicted probabilities of 1993 status for one who fulfilled both CTE and Academic concentrations



Note: Predicted probabilities for each figure are based on the model summarized in Table 9. They are calculated for white males who match the sample mean for socioeconomic status and eighth-grade test scores. The four figures differ in the course-taking sequences of the four hypothetical individuals.

Several important points are highlighted by the figures. First, at a most basic level, the four pie charts do differ from one another in their proportions, illustrating that course-taking patterns do appear to affect postsecondary destinations. Further, none of the four figures depicts a high likelihood of an individual “not enrolling and holding no job” during 1993. This fact is probably encouraging, as “not enrolled/held no job” is the status that is arguably least desirable for a young adult in the years immediately after high school—from both individual and societal points of view.

Figure 4C, which depicts a purely academic concentrator, is the figure that reveals the greatest likelihood of an individual becoming a postsecondary student. If we combine “enrolled/ held no job” with “enrolled/held job(s)/defined oneself as primarily a student,” we isolate the statuses that are “purely or primarily student” statuses. For Figure 4C, the probability of being purely or primarily a student is 0.723. For Figure 4D, the analogous probability is 0.596; for Figure 4A, it is 0.504; and, for Figure 4B, it is 0.373. Thus, controlling for gender, race, SES, and pre-high-school achievement, the purely academic concentrators were most likely to become purely or primarily postsecondary students during 1993. They were followed by the dual concentrators, those who had neither high school concentration, and, finally, those who were purely CTE concentrators in high school.

If we add to the previous set "enrolled/held job(s)/defined oneself as primarily a worker" we have captured all postsecondary student statuses, of all levels of commitment and involvement. Even with this addition, the rank ordering among the four hypothetical individuals remains the same as it was in the previous paragraph: The individual of Figure 4C had an 87% likelihood of holding some sort of postsecondary student status in 1993; the individual of Figure 4D had a 78.7% likelihood; the individual of Figure 4A had a 69.1% likelihood; and the purely CTE concentrator of Figure 4B had a 56.3% likelihood of holding some sort of postsecondary student status.

Switching our focus to employment, we can isolate the statuses that are "purely or primarily worker" if we combine "not enrolled/held job(s)" with "enrolled/held job(s)/primarily worker." For Figure 4B, the probability of being purely or primarily worker is 0.598. For Figure 4A, the analogous probability is 0.478; for Figure 4D, it is 0.394; and for Figure 4C, it is 0.268. Thus—again controlling for gender, race, SES, and pre-high-school achievement—the purely CTE concentrators during high school were most likely to become purely or primarily workers in 1993. They were followed by those who had neither high school concentration, the dual concentrators, and, finally, those who were purely academic concentrators in high school.

Postsecondary enrollment is a relatively likely and viable destination for all four hypothetical individuals; none of these individuals appears to be severely cut off from postsecondary educational opportunities. (Remember, however, that all four hypothetical individuals are of average SES and pre-high-school achievement. See Plank and Jordan (forthcoming) for the distressing talent loss among lower SES students.) Finally, if one goal of coupling career and technical education with academic preparation is to keep multiple attractive postsecondary options open to students, Figure 4D is encouraging as its hypothetical dual concentrator has a very small likelihood (1 percent) of neither enrolling nor holding a job; he has considerable likelihoods of pursuing paid employment, school, or both in the years immediately following high school.

CONCLUSIONS

This report has examined the balance struck between CTE and academic course-taking during the high school years for members of a nationally representative sample of individuals who were eighth graders in the United States in 1988. Further, the report has examined the relationship of this CTE/academic balance with (a) test scores, (b) the likelihood of dropping out, and (c) postsecondary destinations. The balance between CTE and academic course-taking appears to have significant influence on all three outcomes.

This report found that dual and academic concentrators did not differ substantively on standardized tests of mathematics, science, reading, or history. The small, but statistically significant, advantage enjoyed by purely academic concentrators may be attributable to their additional coursework in advanced subjects. These analyses suggest that a middle-range integration of CTE and academic scheduling has significant potential to reduce the likelihood of dropping out. Specifically, a ratio of approximately three CTE credits to every four academic credits was associated with the lowest likelihood of dropping out. Figure 3 showed that this finding is especially salient for individuals who are otherwise at risk of dropping out due to low prior grades, or low prior test scores, or other risk factors.

If a middle-range mix of CTE and academic course-taking can lower the risk of dropping out for some students, educators and policymakers might be wise to encourage such a mix, even if it brings slight reductions in standardized test scores in core academic subjects. Given the importance of a high school diploma in our society, slight reductions in test scores might be found acceptable in exchange for higher graduation rates.

Regarding postsecondary destinations, this report revealed several noteworthy points. First, almost all students in this national sample were engaged in postsecondary schooling, or paid employment, or both, during what was, for most of them, the first full calendar year after high school graduation. This in itself is encouraging news. Secondly, substantial numbers of individuals from each of the four featured high school course-taking sequences (purely academic concentrators, purely CTE concentrators, dual concentrators, and those who had neither high school concentration) pursued postsecondary education; and substantial numbers of students from each course-taking sequence pursued paid employment. Individuals did seem to reach the end of high school with multiple options before them.

Nonetheless, while none of the curricular concentrations during high school completely precluded any of the postsecondary paths analyzed in this report, the curricular concentrations did affect an individual's probability of following one path or another. Controlling for gender, race, SES, and pre-high-school achievement, purely academic concentrators were most likely to become purely or primarily students during 1993. They were followed by dual concentrators, those who had neither high school concentration, and, finally, purely CTE concentrators. Conversely, regarding the world of work, purely CTE concentrators were most likely to become purely or primarily workers in 1993. They were followed by those who had neither high school concentration, dual concentrators, and, finally, purely academic concentrators. In some ways, the results of the analyses of the postsecondary destinations contained few surprises. But they do serve to suggest that the balance struck between CTE and academic course-taking does affect an individual's trajectory after high school. And the results do suggest that some of the goals of efforts to integrate CTE and academic offerings—such as allowing individuals to have multiple attractive options available after high school—are being met at a most basic level.

This report raises several issues deserving of further investigation. For example, even if these analyses have convinced us of the benefits of a middle-range mix of CTE and academic course-taking for some students, many unanswered questions remain about the best ways to integrate CTE and academic offerings. The current National Assessment of Vocational Education (NAVE) is attempting, among its other goals, to assemble case studies and qualitative accounts based on effective programs that integrate academic and vocational education. Important questions include the following: Within integrated programs, are students' academic and motivational outcomes affected by the extent to which their teachers of CTE and academic courses prepare lessons and teach in close collaboration with one another? What are some of the most effective ways for teachers of academic subjects to illustrate linkages between their subjects and career applications? How can CTE teachers forge explicit connections to the academic subjects in their instruction? What sorts of professional development or specialized training do teachers need to support their attempts at integrating academic and vocational education?

It will also be important to attempt to replicate, and build upon, the findings we have generated from the NELS data with more recent data. The NELS subjects attended high school just as the 1990 Perkins Act was beginning to affect the organization of secondary education. Would cross-tabulations of CTE and academic course-taking from the late 1990s or the first years of the 21st century look similar to those from the early 1990s? Would associations between the CTE/academic balance and (a) test scores, (b) the likelihood of dropping out, and (c) postsecondary destinations remain stable? Or have changes occurred? If changes have occurred, can these be traced to influences of the 1998 Perkins Act, with its further encouragement of academic and vocational integration?

Finally, if we accept this paper's suggestions about the curvilinear relationship between the CTE/academic balance and the likelihood of dropping out, many questions arise about why course sequences that are too heavy in either academics or CTE are associated with relatively high rates of school-leaving. Are students at the two extremes of the continuum experiencing pushes away from high school or pulls toward non-high-school endeavors (Gambetta, 1987)? Is it true that, for students who are already at relatively high risk of dropping out, a high school experience that is purely academic offers courses that do not seem highly relevant to their goals or worldviews? Is it the case that a high school experience that is purely academic but aimed at students with low or middle-range achievement is often characterized by unengaging, diluted versions of more challenging and inspiring courses offered to higher-achieving students?

At the other extreme, what characteristics of a high school experience that focuses too exclusively on career and technical education seem to increase the risk of dropping out? Is such a CTE-intensive experience convincing students that they should join the world of full-time paid employment as soon as possible, even if this entails leaving high school prior to graduation? Are a substantial number of students who concentrate heavily in CTE already somewhat disengaged from formal education before the high school years? Do they seek CTE courses in an effort to find their niche within larger high schools, but find that even this niche does not bring the rewards they are seeking? Or is a student's "seeking" not even the relevant part of the phenomenon to explore? Rather, should we focus our attention on the ways that adults and guidance systems within high schools sort and place students, separate from the students' preferences and decisions?

The preceding paragraphs have posed many questions. Most of these are not questions addressed by the present report, but rather are prompted by the report's findings. It would be premature to make strong policy recommendations based on the findings of this report. But, clearly, with the current NAVE, the work of the National Research Center for Career and Technical Education, and many state and local initiatives, we are in the midst of ongoing debate and investigation into the ways that CTE and academic education can best be integrated. It is hoped that this report has offered some new information to this debate, and that future research will provide answers to many of the remaining questions.

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APPENDIX

Appendix Table A1.
Percentages, means, and standard deviations for the variables used in models of 1992 achievement (Tables 3 through 6)[*]

	%	*M*	*SD*
Eighth-grade (1988) math achievement		36.969	11.633
1992 math achievement		48.953	13.688
Eighth-grade (1988) science achievement		19.256	4.695
1992 science achievement		23.667	6.041
Eighth-grade (1988) reading achievement		27.703	8.480
1992 reading achievement		33.528	9.763
Eighth-grade (1988) history achievement		29.967	4.441
1992 history achievement		35.065	5.187
SES		0.004	0.749
Male	49.50		
Female	50.50		
White or other	74.33		
Asian	3.57		
Hispanic	9.54		
Black	11.65		
Native American	0.91		
CTE (no), Acad (no)	37.81		
CTE (yes), Acad (no)	17.85		
CTE (no), Acad (yes)	37.90		
CTE (yes), Acad (yes)	6.44		

[*] All variable summaries are based on the sample of Table 3 (*n* = 8,570) except for science scores (*n* = 8,511, as in Table 4), reading scores (*n* = 8,569, as in Table 5), and history scores (*n* = 8,452, as in Table 6).

Appendix Table A2.
Percentages, means, and standard deviations for the variables used in models of dropping out (Table 8)

	%	*M*	*SD*
Ever dropped out	12.28		
Never dropped out	87.72		
Male	49.18		
Female	50.82		
White or other	72.48		
Asian	3.48		
Hispanic	10.24		
Black	12.65		
Native American	1.15		
SES		-0.058	0.755
Eighth-grade test composite		50.799	9.797
High school g.p.a.		1.910	0.789
CTE/Acad ratio		0.297	0.222
$(\text{CTE/Acad ratio})^2$		0.138	0.198

(n = 11,352)

Appendix Table A3.
Percentages, means, and standard deviations for the variables used in model of postsecondary status during 1993 (Table 9)

	%	*M*	*SD*
Not enrolled, held no job	2.50		
Enrolled, held no job	9.48		
Not enrolled, held job(s)	22.40		
Enrolled, held job(s), primarily student	50.73		
Enrolled, held job(s), primarily worker	14.90		
Male	49.17		
Female	50.83		
White or other	77.26		
Asian	3.71		
Hispanic	8.71		
Black	9.61		
Native American	0.71		
CTE (no), Acad (no)	34.65		
CTE (yes), Acad (no)	18.30		
CTE (no), Acad (yes)	40.13		
CTE (yes), Acad (yes)	6.92		
SES		0.049	0.746
Eighth-grade test composite		52.541	9.768

(*n* = 7,180)