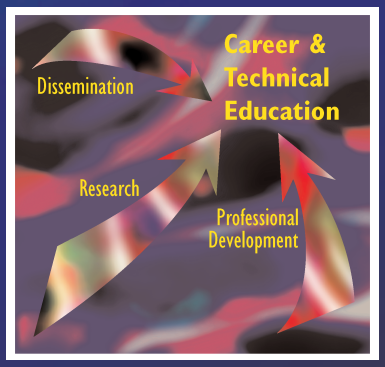

The Effect of CTE-Enhanced Whole-School Reform on Student Coursetaking and Performance in English and Science

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THE EFFECT OF CTE-ENHANCED WHOLE-SCHOOL REFORM ON STUDENT COURSETAKING AND PERFORMANCE IN ENGLISH AND SCIENCE

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ABSTRACT

This is the 4th annual report from a 5-year longitudinal project that examines diverse and promising programs for integrating career and technical education (CTE, previously called vocational education) with whole-school reform in schools that serve predominantly disadvantaged students. Prior annual reports have reviewed the research base on the integration of CTE and whole-school reform, provided preliminary qualitative findings in areas such as leadership, and analyzed student outcome data for mathematics coursetaking and progress toward graduation.

This report continues the analysis of selected measures of student progress—in this case, student coursetaking in English and science, compared to students attending demographically similar control schools that were not involved in concerted reform efforts. On measures of quantity, difficulty, and success of coursetaking, students from the schools with CTE-enhanced reforms either (a) fared better than students from control schools, or (b) were behind control-school students in the early high school years and closed this gap during the later high school years. With respect to English, students from the study schools fared better than students from the control schools. Science results were more mixed, but generally favored students from the study schools.

These findings are consistent with previous reports from this project, and together provide evidence that CTE curricula can be offered successfully without sacrificing core subjects such as English and science. Results presented in this annual report are necessarily preliminary, pending final integration of the data.

EXECUTIVE SUMMARY

This report presents the 4th-year findings from a 5-year longitudinal study designed to examine diverse and promising programs for integrating career and technical education (CTE, previously called vocational education) with whole-school reform. The study is focused within feeder patterns of middle schools, high schools, and community colleges in communities that serve high percentages of families that are economically or socially disadvantaged. Students from these families are, therefore, at risk of not completing high school. The schools participating in this study have implemented CTE-enhanced whole-school reforms to try to improve the educational chances of concentrated groups of highly disadvantaged students.

The larger study was conceived as a way to identify CTE-based reform practices that have been successful in educating disadvantaged students so that they become engaged in school, achieve academically, complete high school prepared for postsecondary education, and succeed in postsecondary education and/or work. As part of that endeavor, the research team compared the English and science coursetaking patterns of students at each of three CTE-enhanced high schools with the English and science courses taken by students at their respective control high schools. Specifically, the present analysis addresses the following questions:

- What are the differences in the quantity, difficulty, and success of English coursetaking among students in the CTE-enhanced high schools and the comparison high schools?

- What are the differences in the quantity, difficulty, and success of science coursetaking among students in the CTE-enhanced high schools and the comparison high schools?

English and science coursework were selected for analysis for several reasons. First, mathematics coursetaking patterns were analyzed previously (Castellano, Stringfield, Stone, & Wayman, 2003). Along with mathematics, English and science are often considered core academic subjects in high school, so an examination of these two subjects completes the comparisons of student academic achievement at the CTE-enhanced high schools and their control schools for the first 2 years of the study. Additionally, English deserves focus because English achievement remains low even among high school graduates. Thirty-six percent of 1998 incoming freshmen at 2-year colleges required some form of remediation (Shults, 2000), and 29% of first-time freshmen at 4-year colleges in 1995 enrolled in at least one remedial course (Phipps, 1998). Remediation is provided at substantial cost to colleges, students, and society at large. It is important to know whether strong English achievement correlates with the CTE-enhanced school reforms being implemented at the schools in this study. Finally, the latest wave of school reform came about because of concern by education and business leaders that United States high school students were not achieving academically on a par with other developed nations of the world (Commission on the Skills of the American Workforce, 1990; National Commission on Excellence in Education, 1983). Two of the areas of greatest concern were the ability to write for various audiences and purposes, and knowledge of scientific principles and facts.

Study Sample

The schools that were selected for inclusion in the study are located in various parts of the country. They are involved in different comprehensive school reform designs and in several CTE reform efforts, and they serve a range of at-risk populations. Included in the study is a comprehensive, grades 9–12 high school, that organized its curriculum around career pathways, or clusters of occupations that require similar skills and knowledge, although they may differ in terms of length of education and training required. A vocational high school is participating in the study. Vocational High School is a member of the High Schools That Work reform design network. Finally, this study includes a high school divided into three academies, encompassing the entire high school. Academy High School is also implementing Urban Learning Centers, a comprehensive school reform design.

Working with the local school districts of the study schools or with neighboring districts, the research team identified matched control schools for each high school. At all control schools, the research team is gathering the same systems-level data that are being collected at the study schools.

Method

The larger 5-year study examines processes and outcomes through a combination of qualitative and quantitative methods. The longitudinal component of the study involves following the progress of three cohorts of students as they proceed through the schools at the longitudinal sites. Cohorts chosen for the study include students who were in 7th, 9th, and 11th grades during the 2000–2001 school year, at both study and control schools. For the present report on high school achievement, participants included students from both sets of schools who were in the 9th or 11th grade during the 2000–2001 school year (the Class of 2004 and the Class of 2002), and who were not participating in Special Education.

Measures

The present report focuses on comparisons of English and science coursetaking patterns at the study schools and their respective control schools. Specific measures include quantity of courses taken, the difficulty of the courses, and student success in these courses.

Results by Academic Subject

On the English measures, students from the study schools typically fared better than students from the control schools. These differences were especially obvious in the Academy High School (AHS) comparisons, where AHS students performed better on measures of English difficulty and English success, and every AHS student took at least one English class during both years of data collection. Comparisons for the Vocational High School (HS) site and the Pathways High School (HS) site typically showed a trend in which study-school students in the younger cohorts were behind their control peers, but study-school students in the older cohorts were comparable to or ahead of their control peers. This closing of a gap in achievement was especially evident in the Pathways HS comparisons, while results were more mixed for the Vocational HS comparisons.

Science measures were more mixed, but generally favored the study schools. Once again, students from Academy HS considerably outperformed students in both control groups. The one exception occurred on the science difficulty measure, where AHS students were behind both control groups. AHS students could take physics only at a nearby college, and records of student participation were unavailable on the district transcripts accessed for this report (these data will be collected from the school and will be available in the final report). Students from Vocational HS typically were behind students from the comprehensive Control-B HS, but were typically ahead of students at Control-B1 HS. The younger cohort of students at Pathways HS (PHS) was comparable to or behind its Control-C counterpart, but older PHS students were ahead of their Control-C peers.

Student achievement in English and science is unacceptably low at all of the schools in this study. Improving student academic achievement in schools with large at-risk populations remains a challenge. However, Kemple and Snipes (2000) are correct to question whether reforms such as career academies, which enhance interpersonal supports and increase access to career awareness and work-based learning opportunities, should be expected to increase student academic achievement. Just as with the Kemple and Snipes study, we found in an earlier report (Castellano, Stringfield, Stone, & Wayman, 2003) that students in the schools with CTE-enhanced reforms were staying in school more than the control students. This has not yet translated into better classroom performance in English or science.

Part of staying in school, however, involves going farther in academic course sequences than school-leavers do. The coursetaking difficulty results show a somewhat consistent pattern in which many students in the CTE-enhanced schools attempted advanced or higher level English and science courses more than the students at the control schools. While this was not found for every cohort, it might explain why student grades in the CTE-enhanced schools were not consistently better than at the control schools: students in the study schools might have been challenging themselves by remaining in academic course sequences longer than students at the control schools did. Future analyses will attempt to reach more definitive conclusions using the last 2 years of data as they become available.

Analyses and refinement of student outcome data continue, as 1 additional year of student data have yet to be collected. Results presented in this report are necessarily preliminary. Within this caution, these results show evidence that CTE-enhanced whole-school reform can be successfully implemented without sacrificing core academic subjects such as English and science.

TABLE OF CONTENTS

Abstract iii

Executive Summary v

Introduction 1

Conceptual Base 3

Literature Review 7
- English Coursetaking and Achievement 7
- Science Coursetaking and Achievement 7
- English and Science Achievement Among CTE Students 8

Study Questions 11

Study Sample 13
- Study Sites 13

Method 19
- Measures and Analyses 19
- Participants 21

Results 23
- English Coursetaking Results 23
- Science Coursetaking Results 31

Summary and Discussion 41
- Limitations 43

Next Phase of the Study 45

References 47

Appendix A. Population Statistics for Cities Served by Study and Control Schools 53

Appendix B. Students Included in Analyses by Gender, Ethnicity, and Free Lunch Program Participation 55

Appendix C. English and Science Course Offerings 57

List of Tables

Table 1. English Coursetaking Quantity: Total Number of English Courses Taken in 2000–2001 and 2001–2002 25

Table 2. English Coursetaking Quantity: ANOVA Tables by Cohort (*F*-Values) 26

Table 3. English Coursetaking Difficulty: Number of Students Who Took at Least One AP or Honors English Course During 2000–2001 or 2001–2002 27

Table 4. English Coursetaking Difficulty: Logistic Regression Models by Cohort (Odds Ratios) 28

Table 5. English Coursetaking Success: English Grade Point Averages from 2000–2001 to 2001–2002 30

Table 6. English Coursetaking Success: ANOVA Tables by Cohort (*F*-Values) 31

Table 7. Science Coursetaking Quantity: Total Number of Science Courses Taken in 2000–2001 and 2001–2002 33

Table 8. Science Coursetaking Quantity: ANOVA Tables by Cohort (*F*-Values) 34

Table 9. Science Coursetaking Difficulty: Science Classification for Highest Level Science Course Taken in 2000–2001 and 2001–2002 36

Table 10. Science Coursetaking Difficulty: Logistic Regression Models by Cohort (Odds Ratios) 37

Table 11. Science Coursetaking Success: Science Grade Point Averages from 2000–2001 to 2001–2002 38

Table 12. Science Coursetaking Success: ANOVA Tables by Cohort (*F*-Values) 39

Table 13. Results: A Brief Summary of Main Points 42

List of Figures

Figure 1. Descriptive Data for Study Schools 18

INTRODUCTION

This is the fourth annual report from a 5-year longitudinal project that has been designed to examine diverse and promising programs for integrating career and technical education (CTE, previously called vocational education) with whole-school reform. The study is focused within feeder patterns of middle schools, high schools, and community colleges in communities that serve high percentages of families that are economically or socially disadvantaged. Students from these families have often been shown to be at risk of not completing high school. The schools participating in this study have implemented CTE-enhanced whole-school reforms to try to improve the educational chances of concentrated groups of highly disadvantaged students. This interim report continues a series of papers on selected measures of student progress—in this case, student English and science coursetaking patterns and achievement.

This study was conceived as a way to identify CTE-based reform practices that have been successful in educating disadvantaged students so that they become engaged in school, achieve academically, complete high school prepared for postsecondary education, and succeed in postsecondary education and work. Prior reports have examined the research base on the integration of CTE and whole-school reform (Castellano, Stringfield, & Stone, 2001, 2003), described the study's multimethod design and provided preliminary qualitative findings (Castellano, Stringfield, & Stone, 2002), and analyzed data for secondary mathematics coursetaking and progress toward graduation (Castellano, Stringfield, Stone, & Wayman, 2003). This report moves beyond mathematics and general progress into two additional academic areas: English and the sciences.

As part of the interim analyses from this ongoing study, in Year 3 the research team compared data from the first 2 years of the study in the content area of mathematics coursetaking and progress toward graduation. This year, the team reports analyses from the first 2 years of data gathering, but in the areas of English and science coursetaking patterns. As before, analyses examine students' English and science course participation at each of three CTE-enhanced high schools and at their respective control high schools. The present analyses address the following questions:

- What are the differences in the quantity, difficulty, and success of English coursetaking among students in the CTE-enhanced high schools and the comparison high schools?

- What are the differences in the quantity, difficulty, and success of science coursetaking among students in the CTE-enhanced high schools and the comparison high schools?

English and science coursework were selected for analysis for several reasons. First, mathematics coursetaking patterns were analyzed previously (Castellano, Stringfield, Stone, & Wayman, 2003). Along with mathematics, English and science are often considered core academic subjects in high school, so an examination of these two subjects completes the comparisons of student academic achievement at the CTE-enhanced high schools and their control schools for the first 2 years of the study. Additionally, English deserves focus because English achievement remains low even among high school graduates. Thirty-six percent of 1998 incoming freshmen at 2-year colleges required some form of remediation (Shults, 2000), and

29% of first-time freshmen at 4-year colleges in 1995 enrolled in at least one remedial course (Phipps, 1998). Remediation is provided at substantial cost to colleges, students, and society at large. It is important to know whether strong English achievement correlates with the CTE-enhanced school reforms being implemented at the schools in this study. Finally, the latest wave of school reform came about because of concern by education and business leaders that United States high school students were not achieving academically on a par with other developed nations of the world (Commission on the Skills of the American Workforce, 1990; National Commission on Excellence in Education, 1983). Two of the areas of greatest concern were the ability to write for various audiences and purposes, and knowledge of scientific principles and facts.

In this report, we first lay out the conceptual framework upon which the study is based. We then provide a literature review on English and science coursetaking and student achievement, including what is known about CTE students and coursetaking in these academic subjects. The research questions of the larger study are then enumerated, followed by a brief description of the schools in the sample and the methods. We analyzed the quantity, difficulty, and success of student coursetaking at each school and their respective control school(s). The results of these comparisons are provided—first for English, and then for science. Finally, we discuss these results, along with their limitations.

CONCEPTUAL BASE

Several research strands provide the conceptual underpinnings for the larger study. These include research on disadvantaged youth and attempts to enhance their engagement and success in school; studies of whole-school reforms and their roles in school change and student achievement; and the literature on a broader conceptualization of career and technical education, which provides an important tool for engaging students in high school (Castellano et al., 2002).

The first important background frame for the larger study relates to research on the challenges faced by disadvantaged students who are at risk of dropping out of high school and, therefore, in need of seeing the concrete benefits of remaining in school. Diverse groups define disadvantaged in somewhat different ways. Various authors prefer the terms *disadvantaged*, *at risk*, *placed at risk*, and *placed at promise* to describe such students (Stringfield & Land, 2002). Without denying the existence of this debate, we use the terms interchangeably to describe students who are at risk of not thriving in traditional education. In this study, we adhere to the definitions provided by Natriello, McDill, and Pallas (1990), and Land and Legters (2002). These authors include persons who are economically disadvantaged (e.g., students eligible for free or reduced-price school meals) and students who are members of groups that have traditionally been regarded as having been discriminated against in United States society (e.g., African Americans, Latinos, and immigrant groups for whom English is not their native language). Both sets of authors note the existence of *concentration effects*, especially in large United States cities, where many high schools are likely to serve high percentages of students living in poverty, racial and ethnic minority students, and non-English-proficient students (Edwards, 1998).

Using conventional district- and state-level definitions, Kaufman, Kwon, Klein, and Chapman (2000) concluded that approximately 11% of all young people between the ages of 16 and 24 throughout the United States have not completed high school or its equivalent. However, using measures that are more precise (e.g., not including self-reported rates of obtaining of a GED), Greene (2002) concluded that high school graduation rates have been declining in the United States, and are currently at 70%. Many urban districts have high school graduation rates below 60%. The economic effects of failing to graduate from high school (e.g., lifetime earnings approximately half those of graduates), and the social costs (e.g., being less likely to participate in such positive social forces as voting, and more likely to serve time in prison) are very well documented (Greene; Stringfield & Land, 2002).

Research on whole-school reform comprises the second conceptual base for this study. By whole- or comprehensive-school reform, we refer to efforts to restructure the organization of a school and the priorities of instruction so that a particular, unified vision of an improved school pervades the school. Whole-school reform always requires additional professional development for a school's entire faculty, with a focus on high standards for all students and enhanced cross-disciplinary cooperation. Forty years of research in diverse educational areas (Newmann & Associates, 1996; Nunnery, 1998; Stringfield et al., 1997) have demonstrated that school reforms are much more likely to have long-term impacts on school culture and student achievement if the change effort involves a schoolwide focus, rather than a targeted one. School personnel are more

likely to see results if they engage in a coherent, unified reform than if they introduce isolated, piecemeal reform practices.

A second significant finding from research on whole-school reform has been that locally developed reform efforts tend to begin with a flurry of committees and design work, but rarely progress to classroom implementation (Nunnery, 1998). For this reason, many schools have adopted externally developed reform designs. Schools have also been spurred by federal funding for Comprehensive School Reform Demonstration (CSRD), a program that began in 1997 with the goal of increasing student achievement "by assisting public schools across the country with implementing comprehensive reforms that are grounded in scientifically-based research and effective practices" (U.S. Department of Education, 2003a).

Various organizations have developed, marketed, and delivered comprehensive school reform designs to schools across the country. In 2003, the federal government provided $310 million in CSRD funding to support K–12 schools interested in adopting these externally developed reform designs. Schools can also use CSRD funds to develop their own approaches to revamping their curricula, instruction, and management around a unifying theme. The goal is for school personnel to look at the big picture and decide on a path of coherent reform toward improvement of student outcomes. Most schools adopt externally developed reform designs. However, these designs will necessarily look different in each school, due to schools' different contexts, histories, and desires or capacities for change. School personnel are said to coconstruct, or adapt, reform designs to their context (Datnow, Hubbard, & Mehan, 2002).

The third background frame for this study supports a broader conceptualization of career and technical education (CTE) as an important tool for engaging secondary students. Hopkins (1999) advocated for an expansive view of CTE in which students are exposed to the contemporary workplace through three non-exclusive approaches: education *through* work, education *about* work, and education *for* work. Education through work refers to strategies in which students learn school subjects within a work context, or work-based learning. Education about work describes a curriculum that assumes that knowledge about the world of work is valid school knowledge. All students need to learn about democratic rights in the workplace, career ladders, and labor markets. Finally, education for work refers to job-specific training. Some argue that such training is best concentrated in the postsecondary phase of students' lives. However, others believe that this is an appropriate role for secondary education (Rosenbaum, 2001). Either way, education for work must be premised upon actual workplace needs, and the curriculum must satisfy the broader educational needs of workers, including general education components and education for participation in a democratic society.

Education through and about work can be infused into academic as well as vocational classes in high school. Teachers can work across subject matter disciplines to integrate their curricula so that students experience real-world uses for curriculum content, such as mathematical equations. Students can participate in internships that use what they have learned in school. Student engagement often increases when they participate in hands-on, real-world learning, as opposed to learning from traditional textbook and lecture methods (Dewey, 1916; Lave, 1988; National

Research Council, 1999). Students see the relevance of what they are learning to contexts outside of school, where many students are oriented and find motivation.

LITERATURE REVIEW

Since 1982, high school graduation requirements in academic subjects have been increasing (Campbell, Hombo, & Mazzeo, 2000). The average number of Carnegie units needed to graduate has risen from 22 in 1982 to 25 in 1998 (Hurst & Hudson, 2000). Murnane and Levy (1996) make the case that that increase in units brings high school graduation requirements only up to high-school-level abilities. In other words, they claim that prior to these increases, students were not necessarily graduating with high-school-level skills. Rosenbaum (2001) argues that today's students are still not graduating with high-school-level skills.

English Coursetaking and Achievement

There is not a body of literature on the relationship between English coursetaking and achievement, as was found in the mathematics (Castellano, Stringfield, Stone, & Wayman, 2003) and science subject areas (see below). Yet, the importance of reading and writing skills for postsecondary ambitions and adult life and work is undeniable. Despite the lack of a strong research base, there are several national indicators of high school achievement in English. For example, the percentage of high school graduates meeting the "New Basics" (National Commission on Excellence in Education, 1983) curriculum standard of 4 years of English has grown. In 1982, 63% of all high school graduates completed 4 years of English; in 1994, this number had risen to 89% (Levesque, Lauen, Teitelbaum, Alt, & Librera, 2000). Four full years of English courses has become a requirement for high school graduation in most states; therefore, the failure to make progress in English can be used as one indicator of likelihood of dropping out of school. Another indicator is the National Assessment of Educational Progress (NAEP) reading test. These scores for 17-year-olds have been essentially flat since 1971 (Campbell et al., 2000; U.S. Department of Education, 2003c).

Science Coursetaking and Achievement

From 1986 to 1999, high school science coursetaking has increased significantly for all major science courses: general science, biology, chemistry, and physics (Campbell et al., 2000). Studies have shown that taking more and more advanced science courses is linked to higher science achievement as measured on tests from the National Education Longitudinal Study of 1988 (NELS:88; Madigan, 1997), and on the Science Reasoning portion of the ACT college entrance exam (McLure & McLure, 2000). While this might seem obvious, the point that many scholars make is that this speaks to an opportunity to learn. Schools in areas with high concentrations of known risk factors (often including high urbanicity) tend to have more limited curricular opportunities (Lee, Burkham, Chow-Hoy, Smerdon, & Geverdt, 1998). Students in schools such as these may not have access to the high-level courses now required by federal, state, and local policies (Oakes, Muir, & Joseph, 2000).

Some research suggests that large urban schools serving high numbers of poor, minority, or immigrant students often lack the resources to offer a broad range of high-level science courses. Urban high schools have tended to offer more general science courses than high schools serving more affluent, low-minority student populations (Lee, Smith, & Croninger, 1997; Oakes, 1990). Even within the same school, studies have found that differential tracking widens the

achievement gap (Braddock & Dawkins, 1993; Gamoran, Porter, Smithson, & White, 1997), because students tend to be sorted into tracks along the lines of social stratification (i.e., the risk factors of race or ethnicity and socioeconomic status).[1] Ingersoll (1999) found that teachers were also tracked, with less qualified teachers or teachers who were teaching out of their field usually teaching lower track classes.

Analyses of NELS:88 science achievement show that higher proportions of non-Latino White students increased their science proficiency during their high school years than did either Latino or African American students, and higher proportions of students from higher socioeconomic backgrounds increased their science proficiency than did students from low socioeconomic backgrounds (Hoffer, Rasinski, & Moore, 1995; Madigan, 1997). There is a need to ensure equity in science-course offerings and opportunity to learn in schools and districts across the nation, especially in light of accountability requirements and the goal of leaving no child behind.

For both English and science, the general increase in academic coursework has not led to an increase in achievement (Clune & White, 1992; Hoffer, 1997). Teitelbaum (2003) found no relationship between increased high school graduation requirements and science achievement as measured on the NELS:88 8th- to 12th-grade science test score gains. It remains unclear how to increase high-school-level English and science achievement among high school students in the United States.

English and Science Achievement Among CTE Students

High school students who concentrate their course of study on CTE tend to have certain characteristics in common. Recent studies have supported previous descriptions of CTE students as being economically more disadvantaged and lower academic achievers than their peers who concentrate on other non-CTE curricular options (Agodini, cited in Silverberg, Warner, Goodwin, & Fong, 2002). CTE concentrators (or even those who take three unrelated CTE credits) who graduated high school in 1992 were also more likely than non-concentrators (i.e., academic concentrators, or those without a concentration) to have scored in the lower third of students on English achievement tests when they were in eighth grade. Agodini found, contrary to previous studies, that a CTE course of study did not attract a higher percentage of minority students than other courses of study, once other factors such as socioeconomic status had been held constant. Agodini noted that these data were from the graduating class of 1992. More current data from the 1997 National Longitudinal Survey of Youth (NLSY97) suggest that CTE concentrators and so-called dual concentrators—those students who complete both an academic and a CTE concentration—are more likely to come from minority and low-income families and enter high school with a lower grade point average (Stone & Aliaga, 2002).

Even with these risk indicators, CTE concentrators have increased their academic coursetaking over the past 2 decades (Levesque et al., 2000). In 1982, CTE concentrators earned

[1] Research has suggested that sometimes minority group students deliberately choose a less demanding track as part of an oppositional stance to schooling (Ogbu, 1987). However, after students get into lower academic tracks, they rarely get out.

an average of 1.72 science credits, 37% of which were in low-level courses. By 1994, CTE concentrators earned 2.39 credits, and only 29% were in low-level courses. In English, the gains were not as clear. CTE concentrators earned an average of 3.79 English credits in 1982, 11% of which were in low-level courses. By 1994, CTE concentrators earned 4.13 credits, but a slightly higher percentage (14%) were in low-level courses.

The percentages of credits that CTE concentrators earn lag behind students in other high school courses of study such as college preparatory students and dual concentrators. However, comparing CTE concentrators to general concentrators, Stone and Aliaga (2002) found that CTE concentrators took significantly more science and higher levels of science. Stone and Aliaga noted that this comparison presents a more realistic picture of changes in science coursetaking behavior, since general concentrators more closely resemble CTE concentrators on measures of ability and household income.

Given the fact that students who pursue a CTE concentration tend to start high school with lower achievement levels and come from lower socioeconomic strata than other students, it is reasonable to assume that many could be at risk of dropping out. However, recent research suggests that CTE can play an important role in keeping CTE students in school. In an analysis of NELS:88 data, Plank (2002) found that the risk of dropping out was lowest when approximately 40% of a student's high school courses were CTE-related. While Plank did not find a corresponding increase in academic achievement among CTE concentrators, clearly students stand a much better chance of improving academically if they remain in school than if they drop out.

Rivera-Batiz (2003) studied the impact of school-to-work activities on minority youth, finding that students who participated in such activities as Tech Prep[2] or career majors were more likely to take more advanced courses in mathematics and science than minority students who did not participate in these broadly defined school-to-work activities. This might be the same phenomenon observed by Plank (2002): The CTE course of study may not directly require students to take more math and science, but CTE opportunities desired by students might be a factor in school persistence and higher level coursetaking.

Some studies have shown that when schools focus their whole-school reform efforts around high academic expectations and CTE themes, English and science coursetaking can increase. In some cases, this increase in coursetaking has led to improvements in achievement. For instance, High Schools That Work (HSTW; Bottoms & Presson, 1995) is a whole-school reform design developed specifically for career and technical education students to ensure that all students get the high-level academics necessary for success in the adult world, including education and work. In HSTW schools that raised the percentage of students taking the recommended core academic curriculum, research shows an associated increase in science, math, and reading scores on the HSTW assessment (Bradby & Dykman, 2002).

[2] For a description of reform designs mentioned in the discussion but beyond the scope of the present analysis, see Castellano, Stringfield, & Stone, 2003.

Talent Development High Schools (TDHS) with career academies—a CTE-centered, whole-school reform design that raises expectations for at-risk students in a personalized, career-themed context (Legters, Balfanz, Jordan, & McPartland, 2002)—provides another example. Studies showed that scores on the state-mandated English test improved at TDHS, compared to the performance of students at those schools prior to implementation of TDHS (Philadelphia Education Fund, 2002). One possible factor, among others, for the positive outcomes for both HSTW and TDHS may be the opportunity to learn provided by the designs.

However, academic improvement is not a given at schools where CTE themes have been incorporated into reform efforts. For example, students in career magnet programs showed no difference in reading test scores compared to their peers who had also applied to the magnet program but were randomly selected out (Thaler & Crain, 1999). Similarly, low-performing students in career academies showed no improvement on reading achievement scores (Kemple & Snipes, 2000).

Simply increasing the number of academic courses required to graduate did not significantly improve overall student achievement over the last 2 decades, and would appear unlikely to close the achievement gap that currently exists between at-risk and not-at-risk students. It is also clear that offering advanced courses is a necessary, if not sufficient, condition for improving student achievement. Once these courses are on the school schedule, school staff must engage youth in a learning endeavor, so that they are motivated to take those courses. Students must recognize the benefits if they are to become motivated to take courses that will be challenging. Rivera-Batiz's (2003) research shows that at-risk students do recognize these benefits and will take challenging courses when they perceive that the benefits outweigh the difficulty of taking the course.

This study seeks to further identify the necessary and sufficient conditions for improving the academic achievement of at-risk secondary students; and this report, focusing on the first 2 years of English and science coursetaking in study and control schools, is another step in that direction. Based on the literature reviewed and previous reviews that describe the promise of CTE-enhanced whole-school reform efforts (Castellano, Stringfield, & Stone, 2003), we hypothesize that students in high schools that have infused their reforms with CTE themes will have better academic outcomes than students in high schools that either do not have any reform efforts underway,[3] or have not incorporated career and technical themes into their reform efforts.

[3] Virtually all schools are perpetually involved in one or more change efforts (Lee & Smith, 2001). However, we sought control schools that were not involved in focused, comprehensive school reform efforts of the type and scope present at the study schools. A description of the sample schools is provided in this document.

STUDY QUESTIONS

The following questions form the basis for the larger study. The first two questions were addressed in the 2nd-year report (Castellano et al., 2002). Questions 5 and 6 concern post-high school and largely community college activities, and necessarily await the gathering of final year data. In this 4th-year report, we continue our examination of measures of progress that lead to the indicators of success listed in Questions 3 and 4. The specific questions that form the present analysis are found in the Introduction.

1. How have comprehensive school reform models affected CTE and overall education in middle schools and high schools—especially those that serve large at-risk populations?

2. How do students choose the pathway, shop, or academy concentration they will pursue for their high school years? Are issues of equity (e.g., encouraging nontraditional career choices, preventing CTE from becoming a dumping ground for low-achieving at-risk students) considered in the structuring of this choice?

3. Has student attainment of proficiencies, credentials, or degrees increased?

4. Have student participation and completion rates for CTE programs, postsecondary education, and employment increased?

5. Have the changes to high schools brought about by comprehensive school reforms in turn influenced community college CTE and postsecondary education overall?

6. How have community colleges adapted their CTE programs in response to changes in the middle schools and high schools where comprehensive school reforms are implemented?

STUDY SAMPLE

The sample for the larger study includes longitudinal, control, and replication sites that were identified and selected through a multistage sampling process. Other reports have discussed the sampling process and the replication sites in detail (see Castellano et al., 2002).

The schools that were eventually selected for inclusion in the sample are located in various parts of the country. They are involved in different comprehensive school reform designs, in several CTE reform efforts, and they serve a range of at-risk populations. We deliberately selected high schools that represented three common high school organizational structures that offer career and technical education. Specifically, there is a comprehensive, grades 9–12 high school, which is the most common high school structure, at about 18,000 nationwide (U.S. Department of Education, 2003b). Like many comprehensive high schools, the high school in this study collaborates with a separate vocational skills center to provide students with half-day focused CTE programs. This skills center is also participating in the study. Because students spend only part of their day at these centers and then return to their home high schools, national data are not collected on these schools. There is no accurate count of how many skills centers there are in the United States, but it is believed that there are approximately 1,100 (Lynch, 2000). A vocational high school is also participating in the study, of which there are about 300 in the nation (Hoffman, 2003). Finally, this study includes a high school divided into academies. This is a fast-growing structure for United States high schools; there were about 1,500 high schools implementing academies in 2000 (Kemple & Snipes, 2000).

Study Sites

Academy High School

Academy High School[4] (AHS) is located in a large urban center in the West. A few of the many products of this large manufacturing center include aircraft, aircraft equipment, aluminum, games and toys, and women's apparel. The city is a hub for trade with Pacific Rim countries. Despite the large manufacturing base, service, retail trade, and government sectors are the leading employers in the county. This city’s population continues to grow, fueled in large part by immigration from Asia and Latin America (for demographic information on all participating cities, see Appendix A).

Academy HS is an Urban Learning Center. This reform design includes three main components (Johnson & McDonald, 1996):

1. Teaching and learning: integrating high standards into a thematic, interdisciplinary curriculum, experiential learning, and school-to-work transitions;

2. Governance and management: all staff and school stakeholders are empowered to collaborate in the decision-making process; and

[4] To protect anonymity, school names are pseudonyms, and all sites are disguised without altering the general characteristics of the schools or communities.

3. Learning supports: health services, social services, and parent education on site.

Urban Learning Centers are K–12 schools housing an elementary school, a middle school, and a high school—all as one integrated facility with one principal. As part of the Urban Learning Centers mandate to create a K–12 learning community campus that includes the teaching and learning elements noted in component 1, Academy HS (AHS) structured its curriculum around career academies. Academies are a school-within-a-school organizational structure in which students choose a career (or other) theme and remain with the same set of teachers for 3 or 4 years of high school, focusing on that theme. The academies at AHS are finance, information technology, and health. All students must be in an academy, making AHS what is known as a "wall-to-wall academy" high school. In the AHS model, English and social studies teachers work with career subject teachers—aligning curriculum, discussing student progress, and jointly evaluating student interdisciplinary projects.

Academy HS, a neighborhood school, has both a strong community focus and a strong career and college preparatory focus. Only students who attend the middle school in the same learning center are eligible to apply to AHS. Because the middle school is over three times as large as the high school (2,500 vs. 700 students), there is an oversubscription of student applicants. In the judgment of Whitehurst (2003), this constitutes a nearly ideal situation for the conduct of an experiment. Students are selected to attend AHS from the pool in a stratified random manner. There are exceptions to the random feature of the draw. The first includes one classroom cohort that has participated in a local, university-based academic enrichment program since the sixth grade. For reasons of continuity, this group is allowed to remain at the learning center through high school if they so wish. Second, AHS has a very limited athletic program. The principal at AHS reports that students interested in participating in athletics, particularly males, are less likely to apply to AHS. To more nearly achieve gender balance, there is an over-sampling of male students in the draw.

When students apply to AHS, they and their parents sign a pledge that they will commit to taking the course of study that makes them eligible to apply to the state university system. They also pledge to apply to college, though they do not have to pledge to actually attend college. Therefore, over and above the academic enrichment program with its explicit university attendance goal, there is an ethic of doing college-preparatory-level work at this school. Indeed, 98% of the 1999 graduating class of AHS was admitted to a postsecondary institution, two thirds of them to 4-year colleges and universities.

Control High Schools A and A1: Academy HS and Control-A High School are located in the same very high-poverty urban community. Control-A HS is a large, urban high school, serving over 2,000 students. This school draws students from the same neighborhood as Academy HS. In fact, Control-A HS receives many of the students who attended middle school at the learning center where Academy HS is located. We therefore provide two sets of control students from Control-A HS: those who attended middle school at the Urban Learning Center (herein noted as

"Control-A1") and those who did not (herein noted as "Control-A").[5] In addition to neighborhood students, Control-A HS has a citywide magnet program on its campus that draws students from the entire city. Magnet students were excluded because of the potential change in sample demographics that these students introduced.

Vocational High School

Vocational High School (VHS) is located in a small city in the northeastern United States. This city has a history as a manufacturing center for textiles and metal. As with many industrial cities in the region, the 1980s brought recession and the offshore flight of much of its industry and manufacturing. Today, the city is revitalizing, although manufacturing employment remains low. Most jobs in the city are in the service sector, in wholesale and retail trade, and in government.

The school district in which Vocational HS (VHS) is located contains four relatively large high schools; VHS serves approximately 1,400 students. For decades, students have had open choice as to which school to attend. Also for decades, middle school guidance counselors advised academically talented students to attend one of the college preparatory high schools, and advised low-achieving eighth graders, students deemed likely to drop out, and many special education students to attend VHS.

Before embarking on its reform agenda, Vocational HS was in danger of losing its accreditation. Adult authority had broken down, gang members openly sold drugs on the school premises, and teachers reported fearing for their safety. New leadership came in 1994 and succeeded in making the school a gang-neutral facility where young people could learn. The school joined the High Schools That Work network (Bottoms & Presson, 1995), which advocates rigorous academic coursework for CTE students, preferably including integrated curriculum. The VHS staff added higher level academic courses and also targeted students who were coming to high school below grade level for extra support.

Given the history of VHS as the recommended high school in the district for students with neither particular academic ambitions nor strong prior academic achievement, helping students reach grade level in math or English became a major focus of the ninth grade. A variety of learning styles are accommodated through the VHS 9th-grade support program, which helps most students progress to grade level during their freshman year. Even the lowest achievers progress several grade levels in math and reading ability.

As a vocational high school, VHS did not traditionally offer a college preparatory curriculum or Advanced Placement courses. Prior to the reforms, students in this district who were interested in a college preparatory curriculum had a choice of three comprehensive high schools. Now VHS

[5] For the Class of 2004 and the Class of 2006, we were further able to identify a group of Control-A1 students who applied for admission to Academy High School but were not accepted. We were unable to identify this group for the Class of 2002, and consequently did not present results for this control group in this report. Presentation of results for this group would result in control groups of different forms for the two AHS cohorts, creating confusion in the reading and interpreting of results. Results for this other control group will be presented at the end of data collection, when the entire high school career will be available for the Class of 2004.

students must meet the same state-mandated academic standards as all comprehensive high schools in the state.

Control High Schools B and B1: The extent of the tracking in this district was such that the director of research and evaluation stated that there was no other high school in the district that could serve as a control for VHS. Hence, we obtained two controls. The first, Control-B High School, is the high school in the district that, in the judgment of district staff, served a population that was the least different from the population attending VHS. Control-B HS recently began an International Baccalaureate (IB) program, although this does not substantially affect the high school experience of the Classes of 2004 or 2002.[6] Second, we sought a vocational high school with similar demographics in another community, and that was not actively engaged in reform efforts. This became Control-B1 High School.

Pathways High School

Pathways High School (PHS) is located in an agricultural area in the northwestern United States, where primary crops are potatoes and wheat. As such, many local jobs involve production agriculture, food processing, and agribusiness. Some industry and manufacturing interests also developed to support nearby federal facilities. Due to its location at the intersection of major rivers and highways, the small city is a transportation hub for the region, with links through air, rail, truck, and barge.

Pathways HS is a large high school (over 2,000 students), and growing so rapidly that the district is planning to build a second high school. This small city has a highly mobile Spanish-speaking immigrant community. The district reported that the migrant population is settling in the city, and fewer migrant families are arriving.

Pathways HS has organized its curriculum around career pathways, or clusters of occupations that require similar skills and knowledge, although they may differ in terms of length of education and training required. For example, a cluster such as Engineering & Industrial Technology provides students with a broad introduction to many fields, including machinist or engineer. This organization of curriculum, sometimes called career majors, replaces traditional placement options such as the college preparatory, vocational, and general tracks.

Students choose from among five broad career pathways at the end of their ninth grade year, after they have completed 2-week units on each pathway in their regular academic classes. Starting in the sophomore year, student experience with pathways is manifest in their elective classes, which should be aligned with their pathways. Examples include journalism, metal fabrication, or 3-D digital animation. In contrast, students' academic classes are not specific to career pathways. That is, students from several pathways may be enrolled in a given English or science course. Academic teachers do attempt to incorporate pathways where possible, and

[6] The Control-B HS Class of 2002 missed the IB opportunity completely. Students from the Class of 2004 who were interested in IB could apply after their sophomore year (i.e., Spring 2002). Data in this report are thus from pre-IB years. However, students in the Class of 2004 were made aware of the program, and if they thought they might be interested, they were advised to take as many honors academic courses as they could in the first 2 years of high school. This advice was not reflected in the results reported here.

encourage student assignments and projects to be based on each student's pathway. Career pathways at PHS provide a focus to the otherwise often diffuse high school experience.

Career pathways form the context for curriculum reform and integrated activities such as senior projects and other interdisciplinary activities. Schools implementing a pathways model need to have strong connections with business and industry and with postsecondary education, in order to provide students internships or other applied experiences. The model is also intended to provide a rigorous, coherent program of study that includes high-level academics in addition to technology applications and work-based learning.

Control-C High School: Pathways HS is the only high school in its district, and its district serves by far the largest number and percentage of low-income, minority, and otherwise potentially at-risk students in its county. Hence, a control school was identified that was not involved in the pathways reforms, and was located less than 50 miles from Pathways High School's small city. As shown in Appendix A, the cities served by both Pathways HS and Control-C HS contain a majority Latino population.

All of the high schools in this study serve a majority of students from contexts traditionally regarded as placing students at risk of educational failure. Figure 1 provides demographic information on the three study high schools. While all three high schools have student populations that are predominantly Latino, these populations are quite different. For example, at Pathways High School, students are predominantly Mexican. Some of these students are members of migrant families and are away for almost half of the school year. The Latino population at Vocational High School is primarily Puerto Rican. Although the city's population is just over one quarter Latino, this high school population is 53.4% Latino—a disproportionate number in relation to the population as a whole. Such an imbalance is not the case at the high schools in the other two cities in the study, where the Latino populations are near or over one half of the entire city's population. At Academy High School, the Latino population is varied, although chiefly Mexican and Central American. No students at either Academy High School or Vocational High School are from migrating agricultural families, since the schools are located in urban areas.

The districts where these schools are located represent a broad range of school district contexts in United States education. Pathways HS is the only high school in its small-town district. The region has a vocational center that provides half-day, specialized CTE instruction; it serves and is funded by 13 area districts. Vocational center data on those PHS students who attend are also being collected. Vocational HS is one of four high schools in a medium-sized city with one district. Students are offered open enrollment to their choice of high schools. Three of the high schools are specifically college preparatory in nature, and Vocational HS is the district's vocational technical high school. Academy HS is in a large urban district with over 60 high schools. The small number of high school students shown in Figure 1 conceals the fact that it is a K–12 facility serving approximately 3,400 students.

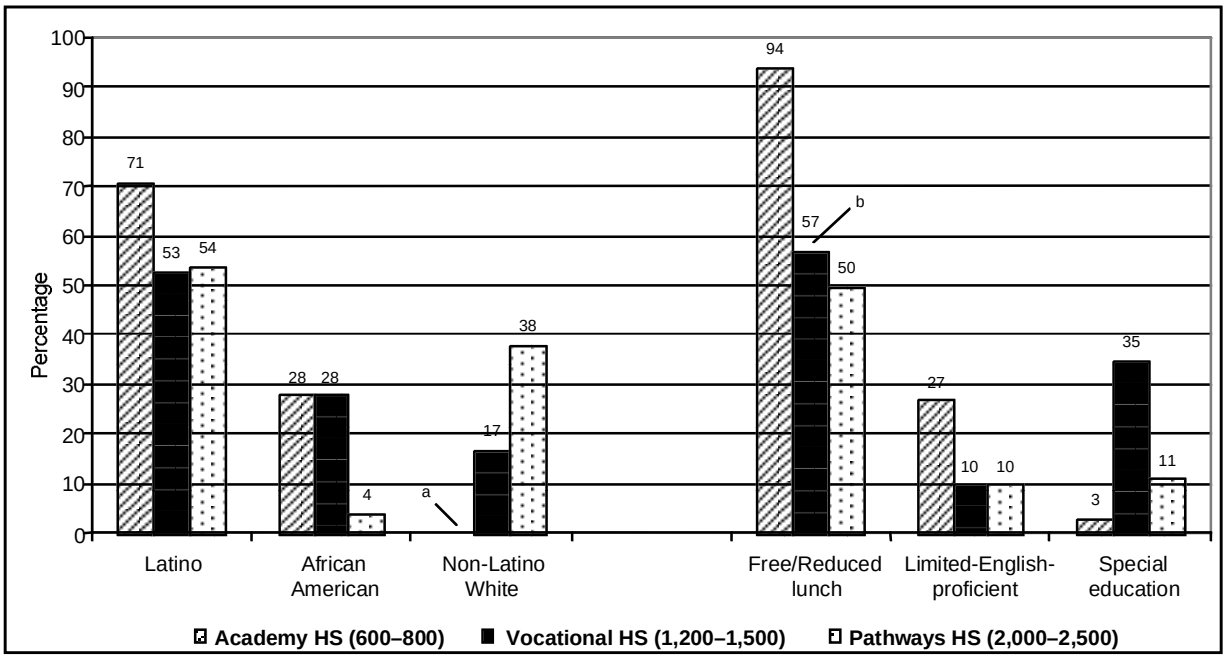

Figure 1. Descriptive Data for Study Schools

Note. All data presented are rounded approximations to further protect the anonymity of the sites. Data derived from public school records. Unless otherwise noted, all data are from the 1999–2000 school year. Data for Academy High School are reported for K–12, but are representative of the high school. All numbers are deliberately approximate to protect the anonymity of participating cities and students.
[a]Non-Latino White for Academy HS is less than 1%. [b]2000–2001 data.

METHOD

The entire longitudinal quasi-experimental study examines diverse processes and outcomes through a combination of qualitative and quantitative methods (Cook & Campbell, 1979; Tashakkori & Teddlie, 1998, 2002). The longitudinal component of the study involves following the progress of three cohorts of students as they proceed through the schools at the longitudinal sites. Cohorts chosen for the study included students in experimental and control schools who were in 7th, 9th, and 11th grades during the 2000–2001 school year. The choice of these grade cohorts allows for examination of the effects of the individual schools on students' progress, as well as an examination of the effects and effectiveness of three critical transitions among schools and community colleges in diverse feeder patterns. Specifically, these cohorts allow the study to shed light on the transition from middle school to high school (grades 7–10), the high school experience, including choosing a CTE concentration (grades 9–12), and the transition from high school to postsecondary education or work (grades 11–14). Although students in these cohorts may be held back a year, they remain in the study cohorts for analysis purposes. For ease of reference, these cohorts are called the Class of 2006, the Class of 2004, and the Class of 2002, respectively, although we recognize that not all students are on target to graduate in those years with their cohort peers. The present report does not include the Class of 2006 because the 2 years of data we collected include the middle school years for this cohort. Previous reports have provided more detail on the methods in the entire longitudinal study (see Castellano et al., 2002; Castellano, Stringfield, Stone, & Wayman, 2003).

Measures and Analyses

The research objectives of the present report are to describe differences between CTE-enhanced and non-CTE-enhanced high schools in the quantity, difficulty, and success of English and science student coursetaking. Quantitative measures reflecting these three dimensions were constructed using official transcript data provided by the school districts. Data were available for the 2000–2001 and 2001–2002 school years for the Class of 2004 (typically the students' freshman and sophomore years) and for the Class of 2002 (typically the students' junior and senior years).

Quantity

To describe the quantity of English and science courses taken, two counts were used—one representing the total number of English courses taken during the 2 years of data collection, and the other similarly reflecting the total number of science courses taken during the 2 years of data collection. We counted courses, not Carnegie units. Future reports will count Carnegie units. In all cases, graduation requirements were the same for each comparison.[7] For this interim report, we accepted each district's classification of courses at face value. For example, courses that a district counted towards the science graduation requirement were considered science courses for the purposes of this report, regardless of whether or not they coincided with, for example, the Secondary School Taxonomy (U.S. Department of Education, 1999). Future analyses will seek to standardize such differences.

[7] All schools required 4 years of English. Academy HS and its controls and Pathways HS and its control required 2 years of science. Vocational HS and its controls required 3 years of science.

Statistical analysis of quantity measures was done using analysis of variance (ANOVA) procedures. For both English and science coursetaking counts, separate ANOVA were conducted for each cohort within each comparison site, using total number of courses as the dependent variable, and experimental group (study or control schools) as the treatment variable. These analyses controlled for the demographic measures of gender, ethnicity, and participation in a free or reduced-price lunch program.

Difficulty

The measures of degree of difficulty of English and science courses were created through examination of course titles and interviews with counselors and schedulers at the study and control schools. For English, a dichotomy was created by dividing students into those who had taken an Advanced Placement or Honors class during the 2 years of data collection, and those who had not. The group that did not take Advanced Placement or Honors English included students who took general English courses, elective English courses, or no English courses.[8]

For science, the Teitelbaum (2003) taxonomy was used. This taxonomy is an adaptation of one developed by Burkam and Lee (1997) for NELS:88 transcript data. The taxonomy divides science courses into four levels: (1) low-level science (e.g., basic biology, earth science); (2) middle-level science 1 (e.g., general or Honors biology); (3) middle-level science 2 (i.e., chemistry or physics); (4) advanced science (i.e., chemistry and physics). For the present report, science difficulty was measured using an amended version of Teitelbaum's taxonomy. Accordingly, those students who took chemistry or physics (level 3 or level 4 in the original taxonomy) were grouped into one category (there were not enough students who took chemistry and physics to allow comparisons using this group). Those students who did not take either chemistry or physics were included in the other categories. Therefore, the new classification schema identifies (1) those who took no science; (2) low-level science (e.g., basic biology, earth science); (3) middle-level science (e.g., general or Honors biology); (4) advanced science (i.e., either chemistry or physics, or both). For the logistic regression analysis concerning science coursetaking difficulty, only the advanced level (chemistry or physics) was used as a dichotomy variable: those students who took either chemistry or physics, and those who did not take either.

Since both difficulty measures were dichotomous, statistical analyses were done using logistic regression modeling. For both English and science course difficulty, separate logistic regression models were estimated for each cohort within each comparison site, using the dichotomous difficulty measure as the dependent variable and experimental group (study or control schools) as the treatment variable. Models were estimated controlling for the demographic measures of gender, ethnicity, and participation in a free or reduced-price lunch program.

[8]A literature search uncovered no classification taxonomies for English. Disparities among the schools regarding course sequencing, elective course definitions, and course offerings left no practical method to empirically develop a more detailed taxonomy that could be applied to all sites.

Success

Coursetaking is not the same as course passing. While the other analyses in this report encompass all English or all science courses that students took, the success analyses also reflect the extent to which students passed these courses. Success in English and science coursetaking was measured through grade point averages (GPA) in the respective subject areas. To assess success in English coursetaking, a participant's English GPA was computed by averaging grades received in all English courses over the 2 years of data collection (A = 4 points, B = 3, C = 2, D = 1, and F = 0 points). Students who did not take any English courses were not included in this measure. Science coursetaking success was constructed similarly; students not taking science courses were not included in the science success measure.

We acknowledge the inconsistency of GPA, and recognize its limitations. We have achievement test scores that will be integrated into the analysis. However, we did not think that such test scores should be the main measure of success, due to their often loose connection to classroom curriculum and instruction. Given that this is a coursetaking analysis, we chose to stay with grades as a measure of success.

Statistical analysis of success measures were done using ANOVA. For both English and science success, separate ANOVA were conducted for each cohort within each comparison site, using grade point average as the dependent variable and experimental group (study or control schools) as the treatment variable. These were conducted controlling for the demographic measures of gender, ethnicity, and participation in a free or reduced-price lunch program.

Participants

For our current analyses, the participant set was limited to non-Special Education students from the study and control high schools who were in the 9th or 11th grade at the start of the 2000–2001 school year ("Class of 2004" and "Class of 2002" respectively), and who remained in their school through the 2001–2002 school year (i.e., had neither dropped out nor transferred to another district). Ethnicity was used as a control variable in the analyses, so participants who were members of ethnic groups with sufficient numbers for comparison were included. Appendix B describes the sample by school and grade cohort in terms of gender, ethnicity, and free or reduced-price lunch program participation.[9] Sample size differences between Appendix B and the following tables are the result of missing data.

[9] Note that the Class of 2002 cohort for Control-B HS has only 12% of students participating in the free/reduced-price lunch program—a figure substantially lower than other cohorts. School officials there have reported that students are hesitant to sign up for the program despite need, because of the stigma they perceive in program participation.

RESULTS

Results from the present study include quantitative analyses of English and science coursetaking measures at all sites. English coursetaking quantity results will be presented, in turn, for each of the three comparison sites and associated control groups. English coursetaking difficulty results will next be presented in the same order (difficulty results for Academy High School, followed by difficulty results for Vocational High School, then by difficulty results for Pathways High School), followed by analyses of English coursetaking success. Examination of science coursetaking will follow in identical fashion. Science coursetaking quantity analyses will be presented for the three comparison sites, followed by science coursetaking difficulty results, then by science coursetaking success results.

English Coursetaking Results

Each set of English coursetaking results (quantity, difficulty, success) will be presented in similar fashion. Appropriate statistical analyses will be presented for each cohort, to compare the study and control groups. These statistical models will use gender, ethnicity, and participation in the free lunch program as independent variables in the ANOVA and logistic regression analyses to contrast study-school data with data from the control school group. We first present results of English coursetaking quantity, followed by results of English course difficulty, and English coursetaking success.

English Coursetaking Quantity

Quantity of English coursetaking was assessed by computing the total number of English courses taken per student during the 2000–2001 and 2001–2002 school years. The available sample for these analyses included all students in school full time for both the 2000–2001 and 2001–2002 school years. Results will be presented first for Academy High School and associated control groups, then for Vocational High School and associated control groups, then for Pathways High School and associated control group.

Academy High School. There were 1,215 participants available for the 2 years of English coursetaking analyses. Table 1 describes the total number of English courses taken by students in the Class of 2004 (students in 9th grade at the start of the 2000–2001 school year) and the Class of 2002 (students in 11th grade at the start of the 2000–2001 school year). Recall that students attending the comparison high school were assigned to one of two control groups: Control-A1, the group that attended the Urban Learning Center middle school, and Control-A, the group that did not.

A striking feature of coursetaking at AHS is that no AHS students opted out of English during the 2 years of data collection. By contrast, 7.23% of the combined Class of 2004 from both control groups took one or zero English classes, with 4% of the Class of 2002 Control-A1 group and 5% of the Class of 2002 Control-A group taking one or zero English classes. It is unusual for a student to avoid English requirements, and especially to do so for 2 consecutive years. Our conversations with school personnel initially suggested that the reasons for this were in line with an unfortunate reality in large high schools: some students “slip through the cracks.”

Subsequent follow-ups will attempt to pinpoint the nature of this phenomenon at Control-A High School.

The number of English courses taken by students in both control groups varied more than that of AHS students. As noted in Appendix C, students at AHS take one English class per year during the first 3 years of high school. This fact is reflected in Table 1, as every member of the AHS Class of 2004 took two English courses during the 2 years of data collection (typically freshman and sophomore years). By contrast, 11% of Control-A1's Class of 2004 took three or more courses, as did 14% of Control-A's Class of 2004. More variety is evident in the older cohorts. AHS seniors may opt to take extra English courses, and Table 1 shows that 13% of AHS Class of 2002 students took three or more English courses over the 2 years of data collection. In the control groups, 24% of the Control-A1 Class of 2002 took three or more English courses, while 21% of the Control-A Class of 2002 did so.

ANOVA analyses (see Table 2) indicate no statistically significant differences in average English coursetaking quantities among the three cohorts for either the Class of 2004 or Class of 2002. However, the fact that no AHS students opted out of English cannot be ignored. AHS appears to be doing a better job of monitoring students' academic pacing than is the case at Control-A HS. One reason might be the wall-to-wall career academies at AHS, since academies create small learning communities where teachers can better monitor student progress.

Vocational High School. There were 1,297 participants available for the 2 years of English coursetaking analyses. Table 1 provides data on the total number of English courses taken by VHS students and their control counterparts during the 2 years of data collection. Recall that two control schools were used for comparisons with VHS: Control-B1 High School (a vocational high school in another city, which is not as actively engaged in reform as VHS) and Control-B High School (a comprehensive high school in the same district as VHS).

Although students at VHS are required to take four English courses, 10% of VHS students from the Class of 2004 (ninth graders at the beginning of this study) took only one English course and, thus, were not on track to complete this requirement after the first 2 years of data collection. The data also suggest, however, that at least some of those students may catch up during their junior and senior years. Thirty-three percent of VHS students from the Class of 2002 took three or more English courses during the 2 years of data collection. Students from both cohorts of the comprehensive Control-B HS were taking extra English, with 19% of the Class of 2004 taking three or more English courses, and 49% of the Class of 2002 doing so. This was not the case in Control-B1 HS (the other vocational high school), where only one student from the Class of 2004 took three or more English courses during the 2 years of data collection, and only 7% of the Class of 2002 did so.

Table 1
English Coursetaking Quantity: Total Number of English Courses Taken in 2000–2001 and 2001-2002

	N for analysis	Number of English courses taken (Percentages for each site and class)				Average number of courses taken
		0	1	2	3 or more	
Academy HS, Class of 2004	170	0	0	100	0	2.00
Control-A1 HS, Class of 2004	193	3	4	82	11	2.01
Control-A HS, Class of 2004	374	5	2	79	14	2.02
Academy HS, Class of 2002	101	0	0	87	13	2.13
Control-A1 HS, Class of 2002	105	1	3	72	24	2.24
Control-A HS, Class of 2002	272	1	4	74	21	2.22
Total N	1,215					
Vocational HS, Class of 2004	173	0	10	87	2	1.91
Control-B1 HS, Class of 2004	290	0	4	96	0	1.97
Control-B HS, Class of 2004	267	0	1	79	19	2.20
Vocational HS, Class of 2002	150	0	2	65	33	2.34
Control-B1 HS, Class of 2002	226	0	0	93	7	2.07
Control-B HS, Class of 2002	191	0	1	50	49	2.57
Total N	1,297					
Pathways HS, Class of 2004	401	4	2	62	32	2.25
Control-C HS, Class of 2004	275	0	1	65	34	2.40
Pathways HS, Class of 2002	301	2	1	51	46	2.54
Control-C HS, Class of 2002	199	2	7	62	30	2.33
Total N	1,176					

Note. N for Analysis represents total number of non-Special Education students from each site who were full-time students in 20002001 and 2001–2002. Percentages are rounded up.

In the Class of 2004, students from Control-B HS averaged 2.2 English courses taken during the 2 years—higher than either Control-B1 students (2.0) or VHS students (1.9). In the Class of 2002, students from Control-B HS averaged 2.6 English courses, students from VHS averaged 2.3, and students from Control-B1 HS averaged 2.1 English courses. ANOVA results (see Table 2) support these findings, as statistically significant differences were found among the study-school groups in both cohorts. From Table 2 it can be seen that the differences in the study-school groups for both 2002 and 2004 classes are particularly high. This reflects the differences in average number of courses taken by students.

Table 2
English Coursetaking Quantity: ANOVA Tables by Cohort (F-Values)

	Dependent variable: quantity of English courses taken				
	Academy HS	Vocational HS		Pathways HS	
	2004	2002	2004	2002	2004
Study school group		34.20	41.06	5.68	6.49
Gender			6.51		6.14
Ethnicity	9.31	3.19			
Lunch program			5.11		

Note. Only statistically significant relationships are reported in each case ($p < .05$). The statistically significant difference for the study-school group is with either of the control groups. Dependent variable is the total number of English courses taken during 2000–2001 and 2001–2002.

Pathways High School. There were 1,176 participants available for English coursetaking analyses. The lower section of Table 1 lists the total number of English courses taken by Pathways HS and Control-C HS students in the Class of 2004 (students in 9th grade at the start of the 2000–2001 school year) and Class of 2002 (students in 11th grade at the start of the 2000–2001 school year).

Students from both schools took more English courses than in the other study pairings. Over 30% of each school's Class of 2004 took three or more English courses over the first 2 years of data collection. Fully 46% of the Pathways HS Class of 2002 took three or more English courses during these 2 years, compared with 30% of Control-C HS Class of 2002.

In the Class of 2004, the site effect was in favor of Control-C HS, where students took more English courses than at PHS. Control-C HS students averaged 2.4 English courses over the 2 years, compared with 2.3 classes for PHS students. Pathways HS students tended to make up this deficit in later high school years, though, as evidenced by an opposite site effect for the Class of 2002 cohort. Pathways' Class of 2002 averaged 2.5 English courses, as opposed to a 2.3 average for Control-C students. ANOVA comparisons between PHS and Control-C revealed significant site effects in both cohorts, controlling for ethnicity, gender, and free lunch program participation (see Table 2). The reported differences in both cohorts for 2002 and 2004 were about the same size.

English Coursetaking Difficulty

English coursetaking difficulty was assessed by examining whether students participated in Advanced Placement (AP) or Honors English courses during the 2000–2001 or 2001–2002 school years. The available sample for these analyses included all students in school full time for both school years. Students were classified into one of two categories: those who took at least one AP or Honors English during the 2 years, and those who did not.

Table 3
English Coursetaking Difficulty: Number of Students Who Took at Least One AP or Honors English Course during 2000–2001 or 2001–2002

	N for Analysis	Ever taken Honors or AP English (%)	
		No	Yes
Academy HS, Class of 2004	170	99	1
Control-A1 HS, Class of 2004	*193*	*100*	*0*
Control-A HS, Class of 2004	*374*	*100*	*0*
Academy HS, Class of 2002	101	30	70
Control-A1 HS, Class of 2002	*105*	*90*	*10*
Control-A HS, Class of 2002	*272*	*91*	*9*
Total N	*1,215*		
Vocational HS, Class of 2004	173	86	14
Control-B1 HS, Class of 2004	*290*	*100*	*0*
Control-B HS, Class of 2004	*267*	*82*	*18*
Vocational HS, Class of 2002	150	71	29
Control-B1 HS, Class of 2002	*226*	*98*	*2*
Control-B HS, Class of 2002	*191*	*76*	*24*
Total N	*1,297*		
Pathways HS, Class of 2004	401	87	13
Control-C HS, Class of 2004	*275*	*82*	*18*
Pathways HS, Class of 2002	301	90	10
Control-C HS, Class of 2002	*199*	*92*	*8*
Total N	*1,176*		

Note. N for Analysis represents total number of non-Special Education students from each site who were full-time students in 2000–2001 and 2001–2002. Percentages are rounded up.

Academy High School. Advanced Placement and Honors English are not prevalent in 9th or 10th grades at either the study or control school, as only one student from the AHS Class of 2004 took an Honors or AP English course, and no student from either the Control-A1 group or the Control-A group took an Honors or AP English class (see Table 3).

The situation was different for the Class of 2002. AHS students are required to take at least one AP course, and the data suggest that many students were fulfilling this requirement through AP English: 70% of this cohort at AHS took AP English, as opposed to 10% in the Control-A1 group (the group that attended the Urban Learning Center middle school), and 9% in the Control-A (the group that did not attend the Urban Learning Center middle school) group.

Table 4 gives results of the logistic regression modeling for the dichotomous English difficulty measure. The dependent variable is whether the student ever took Advanced Placement or Honors courses. For each site, the omitted variable for the control schools is the study school. Only a model for the Class of 2002 is presented; low cell sizes prevented estimation of a model for the Class of 2004 cohort. The site effect was strong, after controlling for demographic variables. AHS students were far more likely to have taken AP or Honors courses than students in either control group: Control-A HS and Control-A1 HS students were merely 0.04 times as likely as AHS students to have taken an AP or Honors course.

Table 4
English Coursetaking Difficulty: Logistic Regression Models by Cohort (Odds Ratios)

	Dependent variable: ever taken Honors or AP English				
	Academy HS	Vocational HS		Pathways HS	
	2002	2002	2004	2002	2004
Control-A1 HS	0.04	—	—	—	—
Control-A HS	0.04	—	—	—	—
Control-B1 HS	—	0.05	—	—	—
Control-C HS	—	—	—	—	2.05
Female	—	—	—	0.20	0.26
White	—	—	2.35	—	—
Latino	—	0.53	—	2.45	5.87
Eligible for free lunch	3.24	—	0.41	4.04	1.91

Note. Only statistically significant predictors are reported in each case ($p < .05$). Omitted variable for the control schools in each site is the study-school group. For AHS model, ethnic comparison is Latino/African American. For VHS models, ethnic comparisons are Latino/African American and White/African American. For PHS models, ethnic comparisons are Latino/White. No AHS Class of 2004 model was estimated due to null comparison cells in control groups. For VHS Class of 2004 model, Control-B1 HS was eliminated due to null comparison cell.

Vocational High School. Advanced English coursetaking appears to be more prevalent at VHS and Control-B HS than at Control-B1 HS (see Table 3). Of greatest interest is that VHS students were taking AP and Honors classes at approximately the same rates as students in the college preparatory high school in the same district (Control-B HS), and at a more advanced rate

than students in the comparison vocational high school (Control-B1 HS). To illustrate, in the Class of 2004, no students from Control-B1 HS were in AP or Honors English, while 14% and 18% of students at VHS and Control-B HS were enrolled in such courses, respectively. Similar trends were found for the Class of 2002, and all sites showed an increase in the number of students taking AP or Honors English: Twenty nine percent of the VHS Class of 2002 took AP or Honors English during the 2 years of data collection, 24% of Control-B HS students took AP or Honors English, and only 2% of Control-B1 HS students did so.

Table 4 shows results of the logistic regression modeling for enrollment in advanced English at VHS and the control schools. For the Class of 2004, Control-B1 HS was removed because no students had enrolled in AP or Honors English. No statistically significant differences were found between VHS and the college preparatory Control-B HS. In the Class of 2002, the statistically significant site effect was due to the low numbers of Control-B1 students in advanced English: Control-B1 HS students were merely 0.05 times as likely to have taken an AP or Honors English class than VHS students.

Pathways High School. In the Class of 2004 (students in ninth grade in 2000-2001), Control-C HS had a higher percentage of students in advanced English (18% to 13%), while in the Class of 2002, PHS had a slightly higher percentage (10% to 8%) (see Table 3).

Logistic regression results for the two cohorts are shown in Table 4. In the Class of 2004, Control-C students were more than two times as likely as PHS students to have taken an AP or Honors English course, and this effect was statistically significant. There was no statistically significant site effect in the Class of 2002 cohort. These results are surprising in that they are counter to the findings for Academy HS and Vocational HS. In this case, it may be due to the fewer number of students in PHS taking these courses, as is shown in Table 3.

English Coursetaking Success (GPA)

English coursetaking success was assessed by computing grade point averages (GPA) for all English courses taken during the 2000–2001 and 2001–2002 school years. The available sample for these analyses included all students in school full time for both the 2000–2001 and 2001–2002 school years, who took at least one English course during that time. Results will be presented first for Academy High School and the associated control groups, then for Vocational High School and associated control groups, then for Pathways High School and associated control group. In general, students in both cohorts at each school in the study had a mediocre average English GPA (see Table 5). The highest GPAs were at about the C+ grade level, with many in the D range.

Academy High School. There were 1,186 participants who took at least one English course during the 2 years of data collection, and thus were available for GPA analysis. Data presented in Table 5 indicate that the English GPA of the Class of 2004 students at AHS was higher than either control group. Students at AHS averaged a half grade-point higher than students in the Control-A1 group (2.46 to 1.96) and the Control-A group (2.46 to 1.91). When compared to that of the control group students, the GPAs of the Academy HS students were significantly different from either (see Table 6).

The English GPA of the AHS Class of 2002 was similar (2.54) to that of the younger AHS cohort, and again higher than that of students in both control groups (2.29 in both cases). Unlike with the younger cohort, these differences were not large enough to be statistically significant when controlling for gender, ethnicity, and free lunch status (see Table 6).

Table 5
English Coursetaking GPA: English Grade Point Averages from 2000–2001 to 2001–2002

	N for analysis	GPA	
		M	*SD*
Academy HS, Class of 2004	170	2.46	1.14
Control-A1 HS, Class of 2004	187	1.96	1.08
Control-A HS, Class of 2004	356	1.91	1.13
Academy HS, Class of 2002	101	2.54	0.87
Control-A1 HS, Class of 2002	104	2.29	1.04
Control-A HS, Class of 2002	268	2.29	1.01
Total N	1,186		
Vocational HS, Class of 2004	173	1.01	0.88
Control-B1 HS, Class of 2004	290	1.67	1.12
Control-B HS, Class of 2004	267	1.50	1.11
Vocational HS, Class of 2002	150	1.69	0.85
Control-B1 HS, Class of 2002	226	2.01	1.04
Control-B HS, Class of 2002	191	2.31	1.12
Total N	1,297		
Pathways HS, Class of 2004	386	2.10	1.22
Control-C HS, Class of 2004	274	2.53	1.11
Pathways HS, Class of 2002	295	2.58	1.03
Control-C HS, Class of 2002	196	2.37	1.05
Total N	1,151		

Note. N represents total number of non-Special Education students from each site who were full-time students in 2000–2001 and 2001–2002, and who took at least one English course during this period. English GPA is figured on the following scale: A = 4, B = 3, C = 2, D = 1, F = 0.

Table 6
English Coursetaking GPA: ANOVA Tables by Cohort (F-Values)

	Dependent variable: English GPA					
	Academy HS		Vocational HS		Pathways HS	
	2002	2004	2002	2004	2002	2004
Study-school group	—	12.83	12.35	15.86	—	29.33
Gender	6.14	21.33	12.69	13.19	58.79	51.14
Ethnicity	—	—	3.30	3.28	25.66	36.74
Lunch program	—	—	—	—	—	8.66

Note. Only statistically significant relationships are reported in each case ($p < .05$). The statistically significant difference for the study-school group is with either of the control groups. GPA for English courses is figured on the following scale: A = 4, B = 3, C = 2, D = 1, F = 0.

Vocational High School. There were 1,297 participants who took at least one English course during the 2 years of data collection. Table 5 shows that students in both VHS cohorts have lower English GPAs than do students in either control group. Table 6 shows the site effect to be statistically significant for both cohorts of 2002 and 2004. In the Class of 2004, VHS students averaged about a half grade-point lower (1.01) than both Control-B1 (1.67) and Control-B students (1.50). A similar trend was evident for the Class of 2002, although differences were smaller. VHS students averaged a 1.69 GPA for their English classes, compared with 2.01 for Control-B1 students and 2.31 for Control-B students. These differences in average GPA have an important effect. ANOVA analysis indicates that there is a statistically significant difference between the VHS and the control groups for both the 2002 and the 2004 classes (see Table 6).

Pathways High School. There were 1,151 participants who took at least one English course during the 2 years of data collection, and thus were available for GPA analysis. The PHS Class of 2004 students (in 9th grade in 2000–2001) had a lower average English GPA than did Control-C students (2.53 to 2.10; see Table 5). Table 6 shows this difference to be statistically significant. For the class of 2002 (students in 11th grade in 2000–2001), PHS students had a higher average GPA in English than their Control-C counterparts (2.58 to 2.37), but it was not statistically significant.

Science Coursetaking Results

Following the outline used to present English coursetaking results, each set of science coursetaking results (quantity, difficulty, success) are presented in similar fashion. First, a descriptive table illustrates the dependent variable at each site. Following this, an appropriate statistical analysis is presented for each cohort, to provide comparisons between study and control groups. These statistical models control for gender, ethnicity, and participation in the free lunch program. We first present results of science coursetaking quantity, followed by results of science course difficulty, and science coursetaking success.

Science Coursetaking Quantity

The quantity of student science coursetaking was assessed by computing the total number of science courses taken per student during the 2000–2001 and 2001–2002 school years. The available sample for these analyses included all students in school full time for both the 2000–2001 and 2001–2002 school years. Results are presented first for Academy High School and associated control groups, then for Vocational High School and associated control groups, then for Pathways High School and associated control group.

Academy High School. There were 1,215 participants available for science coursetaking analyses. Data presented in Table 7 show that the AHS Class of 2004 did not take as many science courses as their control counterparts on average, but the opposite can be observed for the Class of 2002. As with English, one of the most striking features of Table 7 is that no AHS student in either the 2004 or the 2002 cohorts took zero science classes over a 2-year period. Rather, among AHS students in the Class of 2004 (9th graders during 2000–2001), one or two science courses were taken, and among the Class of 2002 (11th graders during 2000–2001), the range was one to three courses. Another revealing finding for the Class of 2004 is that none of the students took three or more science courses—which is quite different, for example, from the PHS students.

For the Class of 2004, Control-A1 and Control-A students averaged more science courses (1.52 and 1.48, respectively; see Table 7) than AHS students (1.32). AHS Class of 2002 participants did average more science classes (1.43) than Control-A1 students (1.27) and Control-A students (1.30).[10] ANOVA analysis for the 2004 cohort shows the site effect to be statistically significant between Academy HS and either of the control groups—an opposite finding from the English coursetaking trends (see Table 8).

Vocational High School. There were 1,297 participants available for science coursetaking analyses. Data presented in Table 7 indicate that VHS students took fewer science courses than the control students in both grade cohorts. However, while in the 2004 cohort, the difference was small (1.81 for the VHS group vs. 1.99 for both control groups); in the 2002 cohort, the difference was larger (1.31 for the VHS group vs. 1.73 for both control groups).

The control groups for both grade cohorts had the same average number of courses taken (1.99 and 1.73 for 2004 and 2002, respectively). The analyses of variance bear this out for both cohorts (see Table 8). The site effect for both cohorts was significant, controlling for gender, ethnicity, and free lunch status.

[10] Recall that AHS students were able to take advanced science classes at a nearby community college, and that those data are not presented here. They will be included in the final report.

Table 7
Science Coursetaking Quantity: Total Number of Science Courses Taken in 2000–2001 and 2001–2002

	N for analysis	Number of science courses taken (Percentages for each site and class)				Average number of courses taken
		0	1	2	3 or more	
Academy HS, Class of 2004	170	0	68	32	0	1.32
Control-A1 HS, Class of 2004	193	2	44	54	0	1.52
Control-A HS, Class of 2004	374	3	46	51	0	1.48
Academy HS, Class of 2002	101	0	57	42	1	1.43
Control-A1 HS, Class of 2002	105	4	67	29	1	1.27
Control-A HS, Class of 2002	272	3	67	28	2	1.30
Total N	1,215					
Vocational HS, Class of 2004	173	1	17	82	0	1.81
Control-B1 HS, Class of 2004	290	0	2	97	1	1.99
Control-B HS, Class of 2004	267	0	2	97	1	1.99
Vocational HS, Class of 2002	150	11	49	40	1	1.31
Control-B1 HS, Class of 2002	226	1	27	70	2	1.73
Control-B HS, Class of 2002	191	4	29	56	11	1.73
Total N	1,297					
Pathways HS, Class of 2004	401	4	5	82	9	1.97
Control-C HS, Class of 2004	275	2	12	65	22	2.08
Pathways HS, Class of 2002	301	34	45	19	2	0.89
Control-C HS, Class of 2002	199	27	47	22	4	1.03
Total N	1,176					

Note. N for Analysis represents total number of non-Special Education students from each site who were full-time students in 2000–2001 and 2001–2002. Percentages are rounded up.

Table 8
*Science Coursetaking Quantity: ANOVA Tables by Cohort (*F-*Values)*

	Dependent variable: quantity of science courses taken			
	Academy HS	Vocational HS		Pathways HS
	2004	2002	2004	2004
Study school group	7.60	20.88	25.16	6.61
Gender	—	—	5.89	5.33

Note. Only statistically significant relationships are reported in each case ($p < .05$). The statistically significant difference for the study-school group is with either of the control groups. Dependent variable is total number of science courses taken during 2000–2001 and 2001–2002.

Pathways High School. There were 1,176 participants available for science coursetaking analyses. It can be seen from Table 7 that most students from the Class of 2004 took at least two science courses over the 2 years of data collection. Interestingly, students from both the PHS and Control-C HS groups for the classes of 2004 and 2002 indicated that they had taken three or more science courses, the largest being 22% of students from Control-C HS class of 2004. In addition, many students at both sites opted out of science during their last 2 years of high school, as shown by figures for the Class of 2002.

PHS students took fewer science courses, on average, than Control-C HS students in both the class of 2004 (1.97 vs. 2.08) and the class of 2002 (0.89 vs. 1.03). Controlling for gender, ethnicity, and free lunch status, the site effect was statistically significant for the Class of 2004 only. The site effect was not significant for the Class of 2002.

Science Coursetaking Difficulty

Science coursetaking difficulty was assessed using the Teitelbaum (2003) science coursetaking taxonomy, as amended (see Method section). The available sample for these analyses included all students in school full time for both the 2000–2001 and 2001–2002 school years. This was the same sample as used for science quantity analyses.

Academy High School. Consistent with the prescriptive nature of AHS coursetaking, all students from the AHS Class of 2004 took mid-level science courses during the 2 years of data collection (see Table 9). This was similar for students in both control groups. It is not surprising that very few students from either the AHS or the control school classes of 2004 took either a chemistry or physics course during this period, since those courses tend to be offered in the junior and senior years of high school. The class of 2004 had only reached their sophomore year

at the time of these analyses. In the Class of 2002, almost all students from both control groups took chemistry or physics during these 2 years, while only 24% of AHS students did.[11]

Since no AHS Class of 2004 participants took chemistry or physics at the high school, we did not estimate logistic regression models for this cohort (see Table 10). The dependent variable in this regression is whether students took chemistry or physics—a measure of high-level science coursetaking similar to the AP or Honors English coursetaking measure. Not surprisingly, the site effect was significant for the Class of 2002, controlling for gender, ethnicity, and free lunch status (see Table 10). Control-A1 students were 32 times more likely to take chemistry or physics than were AHS students, while Control-A students were 27.5 times more likely than AHS students. This was a reversal of the trends for English.

Vocational High School. In the Class of 2004, most students in both the study and control school groups took mid-level science (see Table 9). More students from VHS were in low-level science (27%) than either Control-B1 HS or Control-B HS. No students from VHS or Control-B1 HS took chemistry or physics, and only 2% of students from the college preparatory Control-B HS did. In the Class of 2002, fewer students took chemistry or physics at Control-B1 HS (57%) than at VHS (71%) or Control-B HS (86%). More students in Control-B1 HS took more mid-level science courses than either the VHS or the Control-B HS groups.

Because of null cells for VHS and Control-B1 HS, no logistic regression models were estimated for the Class of 2004. In the Class of 2002, site was a statistically significant factor, controlling for demographic information (see Table 10). Students at Control-B HS were 2.08 times more likely to have taken chemistry or physics than students at VHS. Students at Control-B HS were less likely than students at VHS to take chemistry or physics.

Pathways High School. Students in the Class of 2004 took chemistry or physics earlier at PHS and Control-C HS than at any of the other schools in this report (see Table 9). Of these students, more Control-C students took chemistry or physics during these 2 years than did PHS students, but more Control-C students also took low-level science. More PHS students took mid-level science courses. In the Class of 2002, PHS had a greater percentage of students in chemistry or physics than did Control-C HS, but this latter group took more low and mid-level science courses than did students at PHS.

For the Class of 2004, the logistic regression models (see Table 10) show site to be a significant factor in high-level science coursetaking, with Control-C students 1.89 times more likely to have taken chemistry or physics than PHS students. The converse was true for the Class of 2002, where Control-C HS students were 0.50 times as likely than PHS students to have taken chemistry or physics.

[11] Note that chemistry was offered at AHS, but not physics. It was possible for AHS students to take a physics course at a local college for AHS credit. This information was not available from the district transcripts obtained for these analyses, but may be available from AHS.

Table 9
Science Coursetaking Difficulty: Science Classification for Highest Level Science Course Taken in 2000–2001and 2001–2002

		Science coursetaking difficulty classification (Percentages for each site and class)			
	N	No science course	Low-level	Mid-level	Advanced (Chemistry or physics)
Academy HS, Class of 2004	170	0%	0	100	0
Control-A1 HS, Class of 2004	*193*	*2*	*1*	*96*	*2*
Control-A HS, Class of 2004	*374*	*3*	*1*	*94*	*3*
Academy HS, Class of 2002	101	0	0	76	24
Control-A1 HS, Class of 2002	*105*	*4*	*3*	*4*	*90*
Control-A HS, Class of 2002	*272*	*3*	*4*	*5*	*88*
Vocational HS, Class of 2004	173	1	27	73	0
Control-B1 HS, Class of 2004	*290*	*0*	*12*	*88*	*0*
Control-B HS, Class of 2004	*267*	*0*	*19*	*79*	*2*
Vocational HS, Class of 2002	150	11	14	5	71
Control-B1 HS, Class of 2002	*226*	*1*	*3*	*40*	*57*
Control-B HS, Class of 2002	*191*	*4*	*5*	*4*	*86*
Pathways HS, Class of 2004	401	4	19	63	15
Control-C HS, Class of 2004	*275*	*2*	*30*	*48*	*21*
Pathways HS, Class of 2002	301	34	9	13	45
Control-C HS, Class of 2002	*199*	*27*	*19*	*26*	*28*

Note. N represents total number of non-Special Education students from each site who were full-time students in 2000–2001 and 2001–2002. Science coursetaking difficulty classification represents the highest level of science course taken during either 2000–2001 or 2001–2002. The difficulty levels are: (1) no science; (2) low-level (biology or earth science); (3) mid-level (general or honors science); and (4) advanced (chemistry or physics). Chemistry was offered at AHS, but not physics. AHS students might have taken a physics course at a local college, but such credits are not reflected here.

Table 10
Science Coursetaking Difficulty: Logistic Regression Models by Cohort (Odds Ratios)

	Dependent variable: ever taken chemistry or physics			
	Academy HS	Vocational HS	Pathways HS	
	2002	2002	2002	2004
Control-A1 HS	32.17	—	—	—
Control-A HS	27.47	—	—	—
Control-B1 HS	—	0.52	—	—
Control-B HS	—	2.08	—	—
Control-C HS	—	—	0.50	1.89
Female	2.03	—	—	—
Latino	—	0.55	—	3.91
Eligible for free lunch	—	0.65	—	0.49

Note. Only statistically significant predictors are reported in each case ($p < .05$). Omitted variable for the control schools in each site is the study-school group. For AHS model, ethnic comparison is Latino/African American. For VHS models, ethnic comparison are Latino/African American and White/African American. For PHS models, ethnic comparisons are Latino/White. No AHS Class of 2004 model was estimated due to null comparison cells in AHS. No VHS Class of 2004 model was estimated due to null comparison cells in VHS and Control-B1. These analyses will be available in later reports.

Science Coursetaking Success (GPA)

Science coursetaking success was assessed by computing grade point averages (GPA) for all science courses taken during the 2000–2001 and 2001–2002 school years. The available sample for these analyses included all students in school full time for both the 2000–2001 and 2001–2002 school years, who took at least one science course during that time. In general, students in both cohorts at each school in the study had low average science GPAs (see Table 11). The highest GPAs were at about the C+ grade level, with many in the D range.

Academy High School. There were 1,191 participants who took at least one science course during the 2 years of data collection and thus were available for GPA analysis. As shown in Table 11, AHS students have higher average GPA in both cohorts than students in either control group. In the Class of 2004, AHS students averaged at least a full grade point higher than either of the control groups. AHS students averaged 2.47 for their science grades over these 2 years, while students in the Control-A1 group averaged 1.49, and students in the Control-A group averaged 1.38. The GPA pattern for the Class of 2002 was similar, although less dramatic, with AHS at 2.41, Control-A1 at 2.05, and Control-A at 2.03.

Table 11
Science Coursetaking GPA: Science Grade Point Averages from 2000–2001 to 2001–2002

	N	GPA	
		M	*SD*
Academy HS, Class of 2004	170	2.47	1.23
Control-A1 HS, Class of 2004	*190*	*1.49*	*1.16*
Control-A HS, Class of 2004	*364*	*1.38*	*1.18*
Academy HS, Class of 2002	101	2.41	0.93
Control-A1 HS, Class of 2002	*101*	*2.05*	*1.27*
Control-A HS, Class of 2002	*265*	*2.03*	*1.22*
	1,191		
Vocational HS, Class of 2004	172	1.53	1.16
Control-B1 HS, Class of 2004	*290*	*1.44*	*1.15*
Control-B HS, Class of 2004	*266*	*1.31*	*1.10*
Vocational HS, Class of 2002	134	1.85	1.20
Control-B1 HS, Class of 2002	*224*	*1.82*	*1.15*
Control-B HS, Class of 2002	*183*	*1.65*	*1.13*
	1,269		
Pathways HS, Class of 2004	385	2.24	1.22
Control-C HS, Class of 2004	*271*	*2.21*	*1.20*
Pathways HS, Class of 2002	198	2.41	1.23
Control-C HS, Class of 2002	*145*	*2.55*	*1.28*
	999		

Note. N represents total number of non-Special Education students from each site who were full-time students in 2000–2001 and 2001–2002, and who took at least one science course during this period. Science GPA is figured on the following scale: A = 4, B = 3, C = 2, D = 1, F = 0.

Controlling for gender, ethnicity, and free lunch status, experimental site was a significant factor in both cohorts (see Table 12). In fact, there is a statistically significant difference between the science GPA scores from students in the study-school group and the scores of students in either of the two controls for both classes of 2004 and 2002.

Vocational High School. There were 1,269 students who took at least one science course during the 2 years of data collection and thus were available for GPA analysis. VHS students from the Class of 2004 had higher grade point averages (1.53) than either Control-B1 (1.44) or Control-B students (1.31; see Table 11). This trend was similar in the Class of 2002. VHS students had slightly higher GPAs (1.85) than Control-B1 students (1.82) or Control-B students

(1.65). Results of the ANOVA analysis summarized in Table 12 indicate that the site effect was not statistically significant for either the Class of 2004 or the Class of 2002.

Pathways High School. There were 999 students who took at least one science course during the 2 years of data collection and thus were available for GPA analysis. As seen in Table 11, GPAs for both groups within the Class of 2004 were almost identical (2.24 for the PHS group vs. 2.21 for the control group). In the Class of 2002, Control-C HS students attained a slightly higher GPA (2.55) than students at PHS (2.41).

The site effect was not statistically significant for the Class of 2004, but there was a statistically significant difference between the study- and the control-school groups in the Class of 2002, indicating a site effect (see Table 12).

Table 12
*Science Coursetaking GPA: ANOVA Tables by Cohort (*F-*Values)*

	Dependent variable: science GPA					
	Academy HS		Vocational HS		Pathways HS	
	2002	2004	2002	2004	2002	2004
Study School Group	3.59	48.62	—	—	4.18	—
Gender	—	13.39	10.08	—	14.41	19.64
Ethnicity	—	—	—	4.22	11.31	23.77
Lunch Program	—	—	—	—	—	6.41

Note. Only statistically significant relationships are reported in each case ($p < .05$). The statistically significant difference for the study-school group is with either of the control groups. GPA for science courses is figured on the following scale: A = 4, B = 3, C = 2, D = 1, F = 0.

SUMMARY AND DISCUSSION

This report is the fourth in a series from the longitudinal What Makes It Work study, sponsored by the National Research Center for Career and Technical Education. Prior reports began the examination of academic coursetaking, which the current report continues into two additional academic areas: English and the sciences.

Overview of Quantitative Results

Table 13 provides an integrated overview of the main points from the analysis of results. Generally, students from the study schools either fared better than students from control schools, or were behind in the early high school years and closed this gap during the later high school years. Consistent with prior research on the mathematics coursetaking patterns of these cohorts (Castellano, Stringfield, Stone, & Wayman, 2003), these results show evidence that CTE-enhanced whole-school reform can be successfully implemented without sacrificing core academic subjects such as English and science.

On the English measures, students from the study schools typically fared better than students from the control schools. These differences were especially obvious in the Academy High School comparisons, where AHS students performed better on measures of English difficulty and English success, and every AHS student took at least one English class during both years of data collection. Comparisons for the Vocational High School site and the Pathways High School site typically showed a trend in which study-school students in the younger cohorts were behind their control peers, but study-school students in the older cohorts were comparable to or ahead of their control peers. This closing of a gap in achievement was especially evident in the Pathways HS comparisons, while results were more mixed for the Vocational HS comparisons.

Science measures were more mixed, but generally favored the study schools. Once again, students from Academy HS considerably outperformed students in both control groups. The one exception occurred on the science difficulty measure, where AHS students were behind both control groups. AHS students could take physics only at a nearby college, and records of student participation were unavailable on the district transcripts accessed for this report (these data will be collected from the school and will be available in the final report). Students from Vocational HS typically were behind students from the comprehensive Control-B HS, but were typically ahead of students at Control-B1 HS. The younger cohort of students at Pathways HS was comparable to or behind its Control-C counterpart, but older PHS students were ahead of their Control-C peers.

Student achievement in English and science is unacceptably low at all of the schools in this study. Improving student academic achievement in schools with large at-risk populations remains a challenge. However, Kemple and Snipes (2000) are correct to question whether reforms such as career academies, which enhance interpersonal supports and increase access to career awareness and work-based learning opportunities, should be expected to increase student academic achievement. Just as with the Kemple and Snipes study, we found in an earlier report (Castellano, Stringfield, Stone, & Wayman, 2003) that students in the schools with CTE-enhanced reforms were staying in school more than the control students. This has not yet translated into better classroom performance in English or science.

Table 13
Results: A Brief Summary of Main Points

	Academy High School	Vocational High School	Pathways High School
English quantity	AHS vigilance ensures students take at least one English class every year.	VHS closes gap with Control-B by older grades; VHS comparable to Control-B1 in both grades.	PHS behind Control-C in younger grades, ahead in older grades.
English difficulty	AHS substantially ahead of both control groups.	VHS comparable to Control-B, substantially ahead of Control-B1.	PHS behind Control-C in younger grades, comparable in older grades.
English success	AHS substantially ahead of both control groups.	VHS behind both control groups.	PHS behind Control-C in younger grades, ahead in older grades.
Science quantity	AHS vigilance ensures students take at least one science class every year.	VHS behind both control groups.	PHS behind Control-C in younger grades, ahead in older grades.
Science difficulty	AHS behind both control groups, perhaps because college courses not available on district transcripts.	VHS behind Control-B, but ahead of Control-B1.	PHS behind Control-C in younger grades, ahead in older grades.
Science success	AHS substantially ahead of both control groups.	No difference between VHS and either control group.	PHS identical to Control-C in younger grades, ahead in older grades.

Note. Both control groups for AHS were chosen from a comprehensive high school in the same city as AHS. Control-A1 students attended middle school at the Urban Learning Center; Control-A students did not. Control-B1 HS is a vocational high school that is not reform-focused. Control-B HS is a comprehensive high school in the same district as VHS. Control-C HS is a comprehensive high school in a town near Pathways HS.

Part of staying in school, however, involves going farther in academic course sequences than school-leavers do. The coursetaking difficulty results (Tables 3 and 9) show a somewhat consistent pattern in which many students in the CTE-enhanced schools attempted advanced or higher-level English and science courses more than the students at the control schools. While this was not found for every cohort, it might explain why student grades in the CTE-enhanced schools were not consistently better than at the control schools: Students in the study schools might have been challenging themselves by remaining in academic course sequences longer than students at the control schools did. Future analyses will attempt to reach more definitive conclusions using the last 2 years of data as they become available.

Limitations

As is the case with all interim reports, this report has several important limitations. First, only data from the first 2 of 4 years of student progress are presented (2000–2001 and 2001–2002 school years). Collection of 3rd-year data is ongoing, and final year data will not be available until fall 2004. Therefore the current report is a snapshot view. Over time, with new data, a different picture may emerge. The results of the final analyses may look quite different from what is reported here.

Second, in order to provide comparability on the measures used in this report, the analyses only included participants who were full-time students in the same school for both years of data collection, and hence do not take into account students who left school during this time. Many students who left during these 2 years were school dropouts—a group that typically lags behind continuing students on measures of school achievement. In nearly every case, students in the study-school cohorts left the school at lower rates than did the cohorts at the control schools (Castellano, Stringfield, Stone, & Wayman, 2003). This has important implications for the findings reported here: the positive effects from the CTE-whole-school reform sites are likely underestimated unless school-leavers are taken into account.

Third, analyses do not control for pre-high-school achievement differences. Because of student transience in some schools, 8th-grade achievement data are often unavailable for many students through the district records we accessed. Data presently available are not complete enough to provide an adequate control at every site. The team continues to pursue early achievement data for students missing these measures, and if these efforts are successful, analyses in the final report will control for prior achievement. If not, a complete description will be presented regarding the extent of bias caused by missing achievement data, and if such bias is significant, appropriate statistical techniques for missing data will be employed.

A final caveat to keep in mind is that even when all the data are in, the results of our analyses will only be generalizable to schools with student populations similar to those of the schools participating in the study—namely high-poverty, high-minority students.

NEXT PHASE OF THE STUDY

The year 2004 will be a very busy and obviously pivotal year for the What Makes It Work study. The research team will finalize and prepare both quantitative and qualitative databases for access and analysis. For quantitative data, the team will add 3rd-year data to the analyses completed to date and gather the 4th-year data in academic and CTE coursetaking. These final analyses will control for students who have left school, as this number is significant at some sites and affects achievement results. Separate analyses by various special populations (e.g., Latino, African American, female, initial low-achievers) are also planned.

For qualitative data, the team is using qualitative data analysis software to organize and code the interview and classroom observation data. Expected analyses from the qualitative data include an examination of the specific role that school leaders must play when implementing reforms that have career and technical themes; an analysis of student engagement and acquisition of knowledge in both academic and CTE classes; and various examinations of student transitions, including the transition from middle school to high school, and the transition from high school to postsecondary life.

The advantage of a multimethod longitudinal study is the ability to integrate the quantitative and qualitative data that have been collected at the study, control, and replication sites (see Castellano et al., 2002). In this vein, we foresee integrating the analyses from this and the previous year's report (Castellano, Stringfield, Stone, & Wayman, 2003) with classroom observation data for insights into student academic achievement at the three study sites. The examination of student transitions will be enriched by the integration of 4 years of middle and high school achievement data, with yearly interviews of selected students. The transition from high school to postsecondary education will be examined by integrating high school and postsecondary coursework and achievement information with senior student surveys and community college student focus groups. We will be able to report in some detail on this important transition, in such areas as student need for postsecondary remediation in academic subjects, and student persistence in the academy, vocational program, or pathway area that they chose in high school.

While interpretation of the current results require substantial cautions, the study is on track to complete much more detailed, integrated analyses by the end of Year 5.

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Appendix A
Population Statistics for Cities Served by Study and Control Schools

	City served by Academy and Control-A High Schools	City served by Vocational and Control-B High Schools	City served by Pathways High School	City served by Control-C High School
Total city population	> 2 million	150,000–200,000	25,000–50,000	10,000–15,000
Latino (%)	46	27	56	73
African American (%)	11	20	3	<1
Non-Latino White (%)	30	49	37	25
Asian American (%)	10	2	2	<1
American Indian (%)	<1	<1	1	1
Other/Multiracial (%)	3	<1	4	3

Note. All data are derived from the 2000 U.S. Census (U.S. Census Bureau, 2001). Census respondents are allowed to self-identify in multiple ethnic groups. All numbers are deliberately approximate to protect the anonymity of participating cities and students.

Appendix B
Students Included in Analyses, by Gender, Ethnicity, and Free Lunch Program Participation

				Gender		Race/Ethnicity			Free or reduced-price lunch
				%		%			
	Overall *N*	*N* for analysis	Percent left school	Male	Female	African American	Latino	White	Participation %
Academy HS, Class of 2004	188	170	10	39	61	19	81	n/a	87
Control-A1 HS, Class of 2004	*229*	*193*	*16*	*54*	*46*	*18*	*82*	*n/a*	*87*
Control-A HS, Class of 2004	*563*	*374*	*34*	*52*	*48*	*14*	*86*	*n/a*	*84*
Academy HS, Class of 2002	109	101	7	35	65	19	81	n/a	89
Control-A1 HS, Class of 2002	*125*	*105*	*16*	*45*	*55*	*22*	*78*	*n/a*	*89*
Control-A HS, Class of 2002	*381*	*272*	*29*	*45*	*55*	*15*	*85*	*n/a*	*81*
Vocational HS, Class of 2004	244	173	29	51	49	25	68	7	75
Control-B1 HS, Class of 2004	*395*	*290*	*27*	*45*	*55*	*56*	*35*	*9*	*68*
Control-B HS, Class of 2004	*351*	*267*	*24*	*46*	*54*	*41*	*45*	*14*	*57*
Vocational HS, Class of 2002	186	150	19	47	53	35	47	18	31
Control-B1 HS, Class of 2002	*307*	*226*	*26*	*45*	*54*	*66*	*27*	*7*	*58*
Control-B HS, Class of 2002	*241*	*191*	*21*	*36*	*64*	*50*	*34*	*16*	*12*
Pathways HS, Class of 2004	546	401	27	49	51	n/a	59	41	53
Control-C HS, Class of 2004	*328*	*275*	*16*	*48*	*52*	*n/a*	*67*	*33*	*50*
Pathways HS, Class of 2002	388	303	22	47	53	n/a	43	57	38
Control-C HS, Class of 2002	*277*	*218*	*21*	*48*	*52*	*n/a*	*68*	*32*	*35*

Note. Overall *N* represents the number of non-Special Education students in school at the start of the 2000–2001 school year. *N* for Analysis represents the number of students in school full time for both the 2000–2001 and 2001–2002 school years. Percent left school represents the percent of students in school at the start of the 2000–2001 school year who did not remain in the same school as full-time students through the 2001–2002 school year (e.g., dropout, transfer, part-time students). Insufficient numbers of White students were available for analysis in Academy, Control-A, and Control-A1 groups. Insufficient numbers of African American students were available for analysis in Pathways and Control-C groups. Both control groups for AHS were chosen from a comprehensive high school in the same city as AHS. Control-A1 students attended middle school at the Urban Learning Center; Control-A students did not. Control-B1 HS is a vocational high school near VHS, but is not reform-focused. Control-B HS is a comprehensive high school in the same district as VHS. Control-C HS is a comprehensive high school in a town near Pathways HS. Percentages are rounded up.

Appendix C

English and Science Course Offerings

We compared the English and science graduation requirements and course offerings at each study high school to those at their respective control high school(s). There were no major differences between any study school and its control(s) with respect to graduation requirements. However, the schools varied widely in their course offerings. Some schools offered many more elective choices than others. Some detail is provided below.

Academy High School

Graduation requirements at Academy High School (AHS) and Control-A HS[12] are the same: four years of English and two years of science. Students interested in applying to 4-year universities are encouraged to take a 3rd year of science. Both schools offered AP and Honors sections of English and science. But students at AHS were required to take at least one AP course. This was the only instance we found where a school in this study had an academic requirement above and beyond those of the district or state.

A major difference between AHS and Control-A HS is the near lack of English or science electives at AHS. Given the small size of Academy HS, the academy structure, and their 2-hour block schedule, there was little room in the master schedule for electives. Students at AHS complete their English requirements in a fairly lockstep fashion of one per year. At Control-A HS, students could complete their science graduation requirements with a physical science course in their freshman year and biology during their sophomore year. However, at AHS most sophomores do not take science because their academy requirements take up most of their schedules during their sophomore year. After that, students must take one more science class. Those students interested in advanced science (chemistry, physics) after meeting their graduation requirement would not find physics at AHS during 2000–2001 and 2001–2002. Thus, AHS students interested in taking physics were encouraged to take the course at the local community college, where they could receive both high school and college credit. Many students took advantage of this option, although these courses did not appear on district transcripts provided to us. We are working to incorporate these credits into a revised analysis.

Vocational High School

Vocational High School (VHS), Control-B HS, and Control-B1 HS share the same graduation requirements with respect to academic courses: students must take four year-long English courses and three year-long science courses. All three high schools offered Honors and/or AP English and science in 2001–2002. However, in the case of VHS, all of these classes were Honors; there were no AP offerings. During 2000–2001, only ninth graders (the Class of 2004) had an Honors English course.

All three high schools offered chemistry, but the two vocational high schools (VHS and Control-B1 HS) did not offer physics. Personnel from both schools reported that they offered a "vocational physics" course that was more applied and not equivalent to the advanced level of

[12] Control-A and Control-A1 High Schools are subsets of the same high school.

science that physics is assumed to contain by the authors of the taxonomy used in this report (Burkham & Lee, 1997; Teitelbaum, 2003). Thus vocational physics was not counted as a high-level science course.

Pathways High School

In order to graduate from either Pathways High School (PHS) or Control-C HS, students must take four year-long English courses and two year-long science courses. Students interested in applying to 4-year universities are encouraged to take a 3rd year of science. Both schools offered AP and Honors English and science. Pathways HS also offered many sections of science taught in the first language of many newcomers (Spanish) or using Sheltered English Techniques, which describes a pedagogy for intermediate English speakers. No other school in the study made as large an accommodation to English language learners.