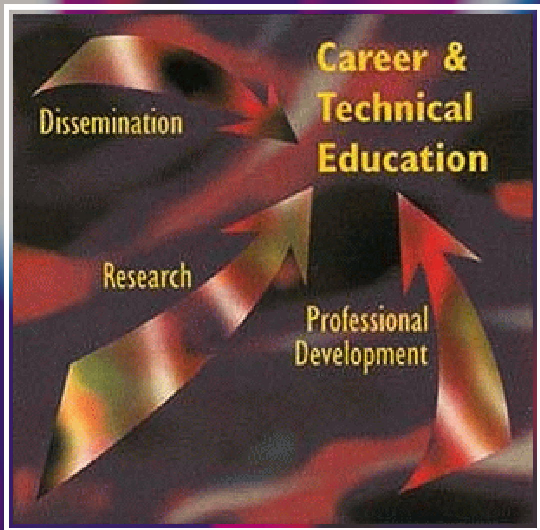

Career and Technical Education Pathway Programs, Academic Performance, and the Transition to College and Career

National Research Center for
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CAREER AND TECHNICAL EDUCATION PATHWAY PROGRAMS, ACADEMIC PERFORMANCE, AND THE TRANSITION TO COLLEGE AND CAREER

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EXECUTIVE SUMMARY

This mixed method study examined secondary student matriculation to two selected community colleges offering career and technical education (CTE) transition programs through partnerships with K-12 and secondary districts having numerous high schools. CTE transition pathway programs seek to help students transition from high school to college and into family-sustaining wage careers. The study had two distinct components: 1) a secondary study that compared CTE and non-CTE students on academic experiences, achievement, and transition into the first semester of college; and 2) a postsecondary study that examined CTE pathway students' transition experiences and outcomes associated with enrollment at the local community college. Both study components utilized qualitative methods to describe policies and practices and quantitative methods to assess how student participation affected student outcomes. A CTE transition program located in the Northwest which offered Information Technology/Computer Information Sciences (IT/CIS) curricula was one site, and a CTE transition program located in the Southeast which offered the Health Alliance curricula, specifically Emergency Medical Technician (EMT), was the second site.

The IT/CIS curriculum in the Northwest site was offered in a total of 52 high schools and was affiliated with a large, comprehensive community college with two campuses. The high schools utilized formal articulation agreements, offering CTE dual credit courses to link the secondary and postsecondary curricula. Students who matriculated to the community college's AAS degree programs specialized in application programming, database development, Web development, digital media, network administration, or hardware technical support. Partnerships between the secondary and postsecondary schools, and especially the contributions of an intermediary agency that promoted relationships among educational partners and employers, made the IT/CIS curriculum possible. Both CTE and Running Start (RS), a dual credit program emphasizing academic coursework, offered dual credit courses and college placement testing to assess students' academic deficiencies and readiness for college.

The Health Alliance curricula in the Southeast site was comprised of the Emergency Medical Services Technology program, consisting of Emergency Medical Technology Basic (EMT-Basic) and Paramedic (EMT-Paramedic) programs offered by a large, comprehensive community college serving a five-county region with multiple campuses. Student completers were eligible for EMT certification, and they could continue their study for the Associate of Science (AS) degree by taking 20 courses in general education and EMT supervision. The curriculum of particular interest to this study was the EMT-Basic Dual Enrollment program that began in 2000 through a partnership between the community college and one local high school. The program was first offered on a local high school campus. Later, having spread to three other high schools, it was offered at the main community college and a branch campus location. The program consisted of an 11-hour EMT-Basic dual credit curriculum offered over a full academic year, with the high school students participating in classroom instruction during the first semester and work-based learning during the second semester. Contextual teaching and learning and career exploration were integrated into the career pathway curriculum.

The results of this study describe students' high school performance, their transition from high school to college and careers, and their college performance, persistence, and credential

attainment. First, with respect to academic achievement, secondary CTE students scored significantly higher than their matched non-CTE counterparts on the Reading for Information subtest of the ACT WorkKeys. Group differences were not evident on the ACT WorkKeys Applied Mathematics sub-test or on overall grade point average at high school graduation.

The secondary study showed that CTE students took significantly more CTE courses and course credits than their matched counterparts. A significant difference was also noted between the groups on dual credit courses, with CTE students taking more than the non-CTE group. In the Northwest site, interaction effects were found between high school IT participation and math course-taking and between IT and science course-taking, revealing that math and science course-taking differed between the IT and non-IT groups in medium engaged schools but not in high engaged schools. This finding may be attributed to the high engaged schools' involvement in whole school reform that encouraged all students to integrate advanced academic courses into career pathway programs of study. Medium engaged schools offered high school IT students opportunities to take math and science courses in association with CTE participation; these same opportunities were not available to non-IT students.

Results of the postsecondary study on a sub-sample of IT/CIS students at the Northwest community college confirmed no differences in the grade point average of the IT/CIS dual credit students compared to the non-IT/CIS group and to the Running Start dual credit group. However, there was a main effect on high school mathematics progress. Though few students in any of the three groups (IT/CIS dual credit, Running Start, and non-participant) completed a full college preparatory curriculum, completion of Algebra 2 or higher was typical, with IT/CIS dual credit students averaging about one level higher by taking a course such as Trigonometry. IT/CIS dual credit students progressed significantly further in math than did non-participants, but there were no group differences in science, English, or foreign language.

Extending results on academic performance from high school to college, the postsecondary study found that the IT/CIS dual credit students were more likely to be college ready than non-participants in communication but not non-participants in math or non-participants overall, after controlling for other factors. Since the IT/CIS dual credit students started at a higher level, on average, in mathematics but not communication than the non-participant group, there is some evidence that IT/CIS dual credit participation may be associated with better college preparation than was the case for non-participants. However, the inability to control for prior academic achievement level lessened the certainty with which a conclusion could be drawn that dual credit participation had a positive effect. Possibly it is the better students in these high schools who chose to participate, and who earned a grade of A or B and thus had their participation reflected in the community college record.

With respect to the transition to college, the follow-up survey conducted as part of the secondary study revealed that CTE students in both sites felt more prepared than their matched non-CTE counterparts to transition to college and careers. CTE students were significantly more likely than non-CTE students to report that high school provided them with information on college programs and courses that follow high school course-taking. At the end of high school, CTE students were also significantly more likely than non-CTE students to report having a clear career goal and a plan to achieve their academic goals. When asked about a series of skills, CTE students were significantly more likely than their non-CTE counterparts to report that they had developed problem-solving, project completion, research, math, college application, work-related, communication, time management, and critical thinking skills during high school.

Also according to the follow-up survey associated with the secondary study, about half of the CTE students reported transitioning from high school to one of the target community colleges. By comparison, the postsecondary study showed a more modest transition rate of 33% for the high school IT students and an equivalent percentage of Running Start students. The IT students were more likely to pursue their career path than their matched non-IT counterparts. Enrollment of high school EMT students at Southeast community college was slightly less than 30%, and no comparison to a non-participant group was possible because of data limitations. CTE students in both sites had a higher rate of self-reported intent to pursue a vocational certificate or degree than non-CTE students.

In the Northwest site, where student records were available for analyzing college persistence, terms enrolled after high school did not differ by group, but there were group differences in college-level credits earned. IT/CIS dual credit students earned more credits than did non-participants, the mean difference being 22.3 credit hours. Running Start participants also earned more credits than did non-participants, by 36.4 credits on the average, and participants in Running Start averaged 14.1 more credits than those in the IT/CIS dual credit group.

Students with higher remedial levels in both math and communication (less remedial need) enrolled in fewer terms than students with a lower remedial level, but earned more college level credit. This suggests that students are not necessarily being hindered in continuing their studies by their need for remediation, at least in the short term, but are continuing their enrollment even though the courses do not add college level credits toward any certificate or degree, thus lowering their total credits earned. This finding may lend support for Adelman's (2006) contention that remediation need not diminish college persistence.

This study offers numerous implications for policymakers and practitioners. First, results suggest that participation in CTE transition programs does not interfere with academic course-taking in that CTE students were equally as academically prepared as matched non-CTE students and other relevant comparison groups. Second, student participation in CTE transition programs was associated with the students feeling more prepared for the transition to college and careers, with numerous results pointing to feelings of confidence and satisfaction regarding choices about college and careers. While the influence of feelings on behaviors is always difficult to predict, the fact that CTE students reported higher levels of preparation for college and careers should be noted as a positive result. Third, despite rather high incidence of remediation, students who required remedial coursework were often retained in college-credit courses and were not impeded in their persistence in college, raising questions about the presumed detrimental impact of remediation on persistence. And fourth, dual credit played a role in participants' accelerated progress and success at earning college certificates and degrees, and therefore suggests that dual credit, in association with academics and CTE, may be an incentive for college persistence and completion.

These findings can inform high school-to-college transition policy and practice pertaining to the implementation of career pathway programs. They are particularly meaningful to implementation of the new federal Perkins legislation that calls for an expansion of career programs of study in that they offer promising results when academic and CTE curricula are integrated with dual credit. These results suggest that CTE transition programs that provide high school students with a dual focus on CTE and academic preparation can facilitate student transition to college and a career without hindering academic performance. They also offer promising opportunities for high school students to develop academic and employability skills that then foster student success in preparing for careers in high demand occupational areas during college.

CHAPTER 1: INTRODUCTION

Interest in Career and Technical Education (CTE) transition programs is growing in the United States (Wood, 2006). The intent of these programs, also called career pathway programs, is to provide students with CTE and academic education that supports their transition from secondary to postsecondary education and into family-sustaining wage careers. Career pathway programs are typically offered by high schools and community colleges and sometimes employer and community-based partners also. The curriculum is expected to be articulated and progressively advanced from the secondary to the postsecondary level, integrating CTE and academic coursework. Some CTE transition programs provide secondary students with the opportunity to obtain college credit prior to high school graduation and college entry, and to transfer their two-year occupational degree to a university (Hughes & Karp, 2006; Warford, 2006). Though the focus of this research does not include adults, career pathway programs can also target adult learners, particularly students who are unemployed or employed in low skill, low wage jobs (see, for example, Prince & Jenkins, 2005).

This mixed method research study was designed to examine CTE transition programs recognized for their exceptional quality as part of the 2000-2002 *Sharing What Works: Exemplary and Promising Career and Technical Education Programs* project. Secondary and postsecondary CTE transition programs identified by *Sharing What Works*, an initiative of the National Dissemination Center for Career and Technical Education, demonstrated evidence of innovation, high quality practices, and promising student outcomes. Though these programs were not required to use a career pathway approach, a sizeable proportion did so. Of the several programs recognized by *Sharing What Works*, an Emergency Medical Technology (EMT) program identified as “promising” in 2000 and “exemplary” in 2002 lent itself to further study of program practices and student outcomes. This program is located in the Southeast region of the United States. A second career pathway program was identified using the *Sharing What Works* criteria. It is an Information Technology/Computer Information Sciences (IT/CIS) program located in the Northwest region of the United States.

The study systematically examined these two career pathway programs by documenting local practices and measuring student outcomes. The study involved two distinct but related parts: a) a study of high school students during the 12th grade and follow-up through their first semester of college, and b) a retrospective study of postsecondary students enrolled in a regional community college that partnered with their high school of attendance where the specified career pathway program was offered. To examine program effects, this study examined the level of engagement in CTE transition programs operating within selected secondary schools to determine whether there were systematic differences in student outcomes by level of school engagement. Results were intended to provide insight into how CTE transition programs operate, including how practices affect students’ academic achievement, transition to college, and postsecondary placement, persistence, completion, and transfer.

Review of the Literature

This review synthesizes literature pertaining to CTE transition programs and career pathways as a means of facilitating student transition to college and careers. It includes a wide range of print and electronic materials associated with high school-to-college transition, academic achievement, transition to college, and various postsecondary outcomes.

Student Transition to College and Careers

Numerous national reports—including, most recently, the Secretary of Education's Commission Report on the Future of Higher Education (2006)—have widened the spotlight from PK-12 (Pre-Kindergarten through grade 12) to include postsecondary education, grades 13-16 and beyond. PK-16 (Pre-Kindergarten through undergraduate education) or PK-20 (Pre-Kindergarten through graduate education) education is highly fragmented and ineffective at moving students through the system from the primary grades through the secondary level to the postsecondary level (Kirst & Venezia, 2004). This is sometimes referred to as the educational pipeline problem. Educators have recenly begun to examine policies and practices to determine better ways to encourage students to matriculate to college, particularly students from demographic groups underrepresented at the postsecondary level (Kazis, Vargas, & Hoffman, 2004). Closing this gap is important because postsecondary education is a predictor of upward social mobility, and youth and parents understand that the acquisition of stable, family-sustaining wage employment is dependent on acquiring some college-level education (Haycock, 2006).

According to the National Center for Educational Statistics (NCES) (2004), over 90% of the 2002 high school sophomore cohort was expected to attend college, with over 70% expecting to complete a four-year college degree. In actuality, 62% of the 2002 sophomore cohort enrolled in college, and nearly half of these students failed to return for a second year. Despite efforts to enhance access to and success in college by aligning and improving curricula, this study and others (see also NCES, 2005) revealed that students who do not achieve successful college outcomes are disproportionately minority, low income, and first-generation college students.

Ewell, Jones, and Kelly (n.d.) called attention to the national policy discussion on student transition to college, noting the promising discussion on PK-16 education reform that emphasizes student achievement and accountability. They credited collaborative partnerships across the levels of the educational system with increasing opportunities for all students to attend college. Callan and Finney (2003) agreed that all students can benefit from education beyond high school because higher education plays an important role in preparing students for careers in a global economy that demands highly skilled employees. Despite the rhetoric about enhancing student access to college to address globalization and workforce needs, curriculum that has attempted to bridge the gap between high school and college has faced implementation challenges or been underutilized. These difficulties have been linked in large part to inadequate financial support, limited institutional capacity, and weak commitment to implementation (Kirst & Venezia, 2004).

Community colleges have emphasized the preparation of employees to fill semi-skilled professional and technical positions associated with the global economy to a greater extent than other postsecondary institutions (Carnevale & Desrochers, 2002). Community colleges are a logical provider of CTE transition programs because they have historically delivered technical education, and their open access mission allows them to enroll substantial numbers of diverse students. Nearly half of undergraduate students attending public institutions of higher education attend community colleges (Phillippe & Patton, 2000), where CTE is a dominant curricular focus (Cohen & Brawer, 2003). Community colleges play an important role in transitioning students into college and preparing them for further education and careers (Hughes & Karp, 2006).

CTE Transition and Career Pathway Programs

CTE transition programs or career pathway programs have emerged over the past two decades as a means to encourage high school students to transition to college and careers (Hull, 2005). In this study, the term *career pathway*[1] is associated with CTE transition programs because it emphasizes an articulated and integrated secondary-to-postsecondary program that begins in high school and continues to the postsecondary level, usually the community college, and ultimately prepares students for family-sustaining wage careers. These programs represent a fundamental change from the vocational education of the past, which emphasized a form of education separate and distinct from the general or college preparatory curriculum (Lynch, 2000; Rojewski, 2002). Modern-day CTE recognizes that the majority of high school students need to be engaged in progressively advanced academic curriculum. By expanding their focus, CTE transition programs are made accessible to high school students who range from students with special needs to students enrolled in college preparatory courses.

Bragg (2001), Lynch (2000), and others have labeled this new form of education the "new vocationalism," wherein CTE emphasizes curriculum alignment, articulation, and integration to facilitate student transition to college and ultimately employment. This new vintage of CTE curriculum encourages student engagement and persistence by helping students see the necessary and reciprocal relationship between their academic and career goals. An underlying assumption is that, once students understand the relevance of their education, they will be motivated to stay in high school and improve their academic performance so college becomes a realistic option (Castellano, Stringfield, Stone, & Wayman, 2003).

Haimson and Deke (2003) reported growing participation in high school CTE during the 1990s, claiming that nearly all students participate in some type of career-focused coursework during high school. DeLuca, Plank, and Estacion (2006) confirmed this result, finding that 90-96% of recent high school graduates have taken at least one CTE course during high school. Drawing data from the National Longitudinal Survey of Youth 1997 (NLSY97), Stone and Aliaga (2003) showed that the proportion of high school students who were dual concentrators—meaning that they took the New Basic curriculum introduced by the National Commission on Excellence in Education (1983) and at least three credits of vocational coursework—has increased, a finding consistent with an NCES report by Levesque (2003). Stone and Aliaga also confirmed logical relationship between dual concentration and participation in career pathways, tech prep, and other career-related programs.

In one of only a handful of studies examining different levels of student participation in secondary CTE and academic curriculum consistent with career pathway programs, Plank (2001) used data from the National Educational Longitudinal Study of 1988 to study the academic

1 Career pathways and career clusters are both associated with CTE; however, we distinguish career pathways from career clusters because we see career clusters as a means of categorizing occupational fields and aligning academic and CTE content with state academic and industry-recognized skill standards (Schmidli, 2001). By contrast, career pathways are a curricular approach that emphasizes boundary-spanning policies and practices that transcend the secondary and postsecondary levels to enable students to matriculate into college without substantial delays or difficulties. While career clusters provide a useful organizing function for careers in terms of the labor market, career pathways provide a framework for aligning and articulating curriculum.

achievement of four groups of high school students: academic concentrators, CTE concentrators, dual (academic and CTE) concentrators, and students who did not fulfill any concentration. Though the results are dated because of reliance on students who graduated from high school in 1992, Plank provided a valuable baseline for comparison to future research. Controlling for background characteristics, he determined that academic concentrators displayed the highest achievement in core academic subjects. The difference between the academic concentrator and dual concentrator groups was statistically significant and favored the academic concentrators, although Plank noted that a large sample size contributed to the significant finding, and he observed that the difference in effect size was minimal. He also reported that a ratio of three CTE credits to every four academic courses was associated with the lowest likelihood of dropping out of high school. Later, Plank, DeLuca, and Estacion (2005) used survival analysis on the NLSY97 dataset to show that a CTE-to-academic ratio of 1:2 reduced students' odds of dropping out of high school. They translated this ratio into 24 Carnegie credits consisting of 13 core academic credits, 6.5 CTE credits, and 4.5 other credits (i.e., foreign language, physical education).

The College and Careers Transition Initiative (CCTI) project of the League for Innovation in Community Colleges (Warford, 2006) is a current initiative that is attempting to advance career pathways. It defines a career pathway as "a coherent, articulated sequence of rigorous academic and career courses, commencing in the ninth grade and leading to the associate degree, and/or an industry-recognized certificate or licensure, and/or a baccalaureate degree and beyond" (p. 8). Warford contends that career pathway programs emphasize courses that are increasingly academically challenging, stating that progressively advanced academic and CTE course-taking is integral to successful student transition to college and careers. Career pathways are sometimes considered a logical extension of technical preparation (tech prep) because they deliberately engage students who are college-bound as well as those who are non-college bound (Bragg et al., 2002; Hershey, Silverberg, Owens, & Hulsey, 1998; Silverberg, Warner, Fong, & Goodwin, 2004).

Elliott and Statelman (2000) described tech prep as offering students rigorous academics integrated with CTE coursework to prepare them for college and eventually employment, and furthered the notion that the two-year college can offer students the opportunity to transfer to four-year colleges and universities. Results of a four-year longitudinal study of eight tech prep consortia by Bragg et al. (2002) showed that students enrolling in consortia offering tech prep programs integrating CTE with advanced math and science showed higher advanced math- and science-course taking behavior, despite the fact that the vast majority of students were not high achieving. This study also showed that about 80% of tech prep participants enrolled in college, especially community college, within two years of high school graduation. Despite these results on college transition, challenges to implementation of tech prep have raised questions about its ability to facilitate students' transition from high school to college (Hughes & Karp, 2006). Elliott and Statelman (2000) and Silverberg et al. (2004) suggested that vagueness in the legislation and excessive flexibility in local approaches contributed to the implementation problems.

Whether CTE transition programs or career pathways are rooted in tech prep or other models, their value rests on their reliance on a balanced approach to curriculum. Students are no longer expected to choose between the academic track and the CTE track, but are expected to participate in rigorous, integrated coursework that provides a well-rounded, comprehensive approach to education. Students' in-school learning experiences are supplemented with work-based learning opportunities outside the classroom, with guidance and counseling support, and with various educational activities designed to support their successful transition to and through college and into family-sustaining wage careers.

Core Components

CTE transition or career pathway programs offer a number of components that define students' experience as they progress from secondary to postsecondary education. According to Hull (2005), Hughes and Karp (2006), and Warford (2006), primary among these components are integrated curriculum and contextual learning, work-based learning, dual credit and dual enrollment, guidance and counseling, and activities that encourage a smooth transition from high school to college. Relative to these components, studies (e.g., Adelman, 2006; Calcagno, Crosta, Bailey & Jenkins, 2006) of student outcomes associated with transition to college, postsecondary enrollment and remediation, and postsecondary persistence, certificate and degree completion, and transfer are reviewed and discussed.

Integrated Curriculum and Contextual Learning. Arguments for CTE transition programs are rooted in the belief that students who participate in CTE experience learning that is more relevant, practical, and useful than traditional instruction (Dare, 2006). Reflecting a comprehensive view of curriculum, Plank (2001) observed that "advocates of combining vocational concentration with college preparation suggest motivational benefits" (p. 2) to balancing academic course-taking with CTE. The integration of CTE with academic courses is often associated with students gaining knowledge and skills in subject matter that complements and reinforces abstract as well as practical learning. As a result, students become engaged and are motivated to remain engaged both because they are stimulated intellectually and because they can readily see how their learning applies to their lives (Stone & Aliaga, 2003).

In providing a context within which academics can be taught, CTE instructors use a range of practices to motivate students to learn and persist to completion. CTE transition programs provide students with contextual learning in the classroom and work-based learning arrangements outside of school, including internships, apprenticeships, and job shadowing (see further discussion of work-based learning below). These instructional practices are thought to help students connect their academic studies to work, linking learning in classrooms and laboratories with the real world. Consistent with a contextual learning approach, Grabinger (1996) argued that CTE students are more able to directly apply and test their knowledge in real-life situations than students who have not had these kinds of learning opportunities. CTE experiences are expected to have a value-added impact on the knowledge students acquire, heightening their commitment to complete their educational programs and to seek viable employment opportunities.

Though few studies have used sufficiently sophisticated methods to ferret out the benefits of CTE transition programs, a few studies have attempted to do so, with mixed findings. In a study of academic achievement, the Southern Regional Education Board (SREB) (2000) reported that CTE students met the national average on the National Assessment of Educational Progress (NAEP) reading, math, and science exams, in some instances outperforming non-CTE students (Bottoms, n.d.). This study was based on results on the academic performance of students from 635 schools that participated in the High Schools That Work (HSTW) reform. Contrasted with these results, a five-year longitudinal study by Castellano, Stone, Stringfield, Farley, and

Wayman (2004) concluded that "students with CTE-enhanced reforms were staying in school more than the [students enrolled in] control schools [although] this has not yet translated into better classroom performance in English or science" (p. vii). These results are based on the performance of students in high-poverty communities with high schools implementing CTE-enhanced whole school reform employing models paralleling career pathways. Castellano et al. (2004) suggested that an increase in academic course-taking by all students during the period of the study, linked to the federal No Child Left Behind (NCLB) legislation and state reforms, resulted in enhanced performance for all students. Thus, while positive results were evident, the extent to which they reflected the impact of the CTE reforms emphasizing integrated academic and CTE curriculum or the requirements for increased academic courses for all students could not be determined. Stone and Aliaga (2003) made a similar observation about the heightened importance of academic course-taking for all students, noting that all of today's high school students are taking more mid- and high-level math courses than students in the past. As a consequence, there is a tendency for all students, including CTE students, to experience enhanced levels of academic course-taking and to display improved academic performance.

Work-based Learning. In addition to integrated curriculum, work-based learning is often implemented as part of career pathway programs. Work-based learning has been described as a tangible means of connecting students' school-based learning with the workplace (Urquiola et al., 1997) to help them acquire occupational knowledge and skills, engage in career planning and explore careers, learn all aspects of the industry, improve work-related personal and social competence, and increase motivation and academic achievement. Examining the impact of work-based learning as a core component of school-to-work programs, Haimson and Bellotti (2001) documented the growth of work-based learning involving observational experiences such as job shadowing. They found that students thought job shadowing and internships were helpful to career planning, and they were most satisfied when work-based learning was customized to fit their personal college and career goals. Work-based learning assignments secured by the schools rather than the students provided particularly valuable learning experiences.

Despite the support for work-based learning, results are mixed on its impact on academic learning and achievement. In one of the few studies to address this question, Hughes, Moore, and Bailey (1999) examined whether work-based learning reinforced content knowledge and skills-oriented knowledge in reading, math, and science at the secondary and postsecondary levels. They found some support that work-based learning reinforces academic knowledge, concluding that when work-based learning moved beyond episodic exposure to complex work-related knowledge and skills, students gained the greatest pedagogical benefits. An earlier, noteworthy study by Hamilton and Hamilton (1997) reinforced these results, showing little or no effects on students' academic achievement related to their participation in youth apprenticeships. Considering the mixed results of these and other studies, Hughes et al. (1999) cautioned researchers not to generalize about the impact of work-based learning without understanding the pedagogical approach. They concluded that poor placements lead to "dismal, mis-educative experiences, while quality work-based learning can provide benefits above and beyond what students get even in excellent classrooms" (p. 9).

Dual Credit and Dual Enrollment. While accelerated learning opportunities have existed for well over 30 years, the growth of programs and courses that award college credit simultaneously with high school credit, known as dual credit programs/courses, has been a fairly recent phenomenon[2] (Bragg, Kim, & Barnett, 2006; Karp, Bailey, Hughes, & Fermin, 2004). Clark (2001) documented the existence of high school courses that also award college credit in a wide range of academic as well as CTE subjects. In its various forms, dual credit is associated with potentially improved coherence between high school and college curricula, increased access to college, and reduced need for remedial coursework, improved quality of technical training for workers, and easier recruitment of students to college, and reduced college expenses (Bailey, Hughes, & Karp, 2003; Fincher-Ford, 1996). Without question, these intended benefits are laudable, but the research verifying them is limited.

Documenting the recent proliferation of dual credit, Waits, Setzer, and Lewis (2005) and Kleiner and Lewis (2005) showed that almost three-quarters of high schools in the United States offer students the opportunity to earn dual credit, translating into slightly over 800,000 students (about 5% of all high school students in the United States), and more than half of the nation's colleges and universities enroll high school students in college courses that award dual credit. By 2002-03, dual credit programs were nearly universal in public two-year colleges (including community colleges), with 98% offering such programs. Hoffman (2005) estimated that as many as 50% of dual credits are accumulated by students enrolled in CTE.

To examine the impact of different forms of accelerated learning—specifically, academic dual credit, CTE dual credit, and CTE articulated credit—on student outcomes, Kim (2006) conducted a secondary analysis of a partial data set from Bragg et al. (2002). Applying statistical controls through multiple regression and logistic regression analyses, Kim (2006) reported that academic dual credit courses had a positive impact on students' college placement but a negative impact on community college credits earned, suggesting that secondary students did not continue their college enrollment in the lead community college. Though the study did not track students to other higher education institutions, Kim speculated that many students transferred their dual credits to four-year colleges and universities. Kim's study also revealed that students taking CTE articulated courses earned more community college credits than students who had taken academic dual credit or CTE dual credit courses. Moreover, CTE dual credit courses were not associated with college placement or college retention.

Guidance and Counseling. For all students, the provision of career information that supports decision-making about college and careers and assists in developing and meeting educational goals is important (Furstenburg & Neumark, 2005; Schneider & Stevenson, 1999). The Perkins Vocational and Applied Technology Education Amendments of 1998 (Perkins III) linked career guidance to academic preparation, recommending that guidance services address occupational and academic options as well as financial aid. Since then, the guidance and counseling function has encompassed a wide range of interventions, including academic advisement and career development. Even more emphasis was placed on career guidance in the

2 While *dual enrollment* and *dual credit* are used interchangeably in the literature, we prefer the term *dual credit* because it clearly denotes college credit earned by secondary students who have yet to graduate from high school, thereby transcripting credit at the secondary and collegiate levels simultaneously. We contrast *dual credit* with *articulated credit*, which refers to credit deferred until students graduate from high school and enter college. Sometimes students are required to take a proficiency test or pass a specified number of college credit hours with a grade of C or better in order to secure the credits taken during high school.

Carl D. Perkins Career and Technical Education Improvement Act of 2006 (Perkins IV), which recognized that limited guidance services continue to be available to students in U.S. high schools.

Parsad, Alexander, Farris, and Hudson (2003) highlighted the lack of focus on high school guidance services and its impact on students, reporting survey results showing that guidance personnel favored career pathways as a means of organizing advising services for students. Their findings supported other studies (see, for example, Rosenbaum, Miller, & Krei, 1996; Schneider & Stevenson, 1999) showing that high school guidance and counseling personnel spend the preponderance of their time on administrative duties, leaving little time to provide students with information to help them make decisions about college and careers. These results are bolstered by the Career Institute for Education and Workforce Development (2002) survey that showed that 46% of high school juniors and seniors are not offered any form of advising on career options. As a consequence, students do not link their high school course-taking to college or career decision-making, and thus have lower motivation to engage in challenging academics (Allum, 1993; Kirst & Venezia, 2004).

The High Schools that Work (HSTW) initiative reinforced the importance of the relationship between guidance and counseling and academic performance, concluding that "challenging coursework, good relationships between academic and career/technical teachers, [and] better communication among students and guidance counselors are associated with higher test scores" (Bradby & Dykman, n.d., p. 1). These researchers found a strong association between students' engagement with faculty and counselors and academic achievement, showing that students who spend more time talking to teachers and counselors about their high school program also experience a rise in test scores. CTE transition programs and career pathways recognize that secondary students benefit from guidance that helps them select a meaningful educational and career path (Schwallie-Giddis, Creamer, & Kobylarz, 2006; Warford, 2006). Rumberger (2003) suggested that effective guidance services give students a better chance to understand how their high school studies can assist them in "achieving the educational and career goals to which they aspire" (p. 8). Schwallie-Giddis et al. (2006) agreed with this perspective, observing that

> effective counseling in Career Pathways produces tangible results—more students thinking about careers at the beginning of high school, more students making smooth transitions from secondary to postsecondary, more students beginning their colleges [sic] careers with college credits already in hand, and more students leaving high school with a clear sense of direction and the tools necessary to reach their goals. (p. 225)

Transition to College. High schools and colleges can offer a host of programs and services to help students matriculate to college smoothly. Based on their review of a national sample of secondary-postsecondary learning options (SPLOs) with data on program effectiveness and student outcomes, Lerner and Brand (2006) concluded that "extra supports" (p. 120) are vital to helping students transition to college, particularly students who are historically underserved by postsecondary education. Their research points to the importance of caring adult advisors, academic supports including college success classes, and mentoring and peer support networks to helping students bridge the academic and cultural divide between the secondary and postsecondary level. Tierney and Auerbach (2005) support these transition strategies, adding family involvement as a crucial factor in students' college decision-making. Prominent among the factors influencing how parents advise their children is cost, with low- income families frequently overestimating the cost of college and thereby negatively affecting their children's decisions. Accurate information about college costs and financial aid early in the college decision-making process is crucial to students' decisions about college.

Outcomes Associated with CTE Transition

Though limited research documenting student outcomes relative to CTE transition exists, this section discusses studies pertinent to student transition from high school to college that apply to emerging career pathway programs.

Transition to College. The relationship between CTE transition program participation and transition to college has been examined in only a few studies, with most showing increased college attendance for students who engaged in CTE course-taking but differing on how they attribute this positive outcome. As part of the National Assessment of Vocational Education (NAVE), Silverberg et al. (2004) confirmed improved academic performance and transition to college among students who take secondary vocational courses. They attributed these positive results to students' increased academic course-taking rather than CTE or integrated academic and CTE programs of study, failing to see combined academic and CTE course-taking as a concerted, programmatic approach. Relying on national data sets, this study and others of this type were unable to account for other variables that could account for college transition behavior such as the college advising, mentoring, and financial aid mentioned above. Similarly, using NLSY97, DeLuca et al. (2006) showed that higher ratios of CTE-to-academic courses were related to reduced odds of college attendance, even after controlling for student background characteristics. The authors recognized multiple problems with the study because of limitations within NLSY97, including the inability to examine students' opportunities to attend college and their college aspirations and the limited opportunity to follow students beyond high school graduation.

Postsecondary Enrollment and Remediation. The growth of CTE transition or career pathway programs over the past two decades has paralleled the growth of technical education offered by community colleges. Drawing traditional- and non-traditional-age students, participation in postsecondary CTE has grown as more students have sought technical degrees in preparation for a global workforce that requires higher levels of technical-skill preparation. Silverberg et al. (2004) reported that one-third of all undergraduate students participate in postsecondary vocational programs. These programs enroll a highly diverse student population reflective of the increasing diversity of the United States population at large. Using a relatively new taxonomy to classify undergraduate curriculum according to academic and career majors, Hudson and Shafer (2004) found that over 70% of two-year college students enroll in vocational career majors, with over half (57%) majoring in business/marketing, health care, or computer science.

Enrollment in remedial courses is commonplace for entrants to community colleges, regardless of the program of study in which they enroll. The National Center for Education Statistics *Condition of Education 2003* report confirms that virtually every community college in the nation offers remedial courses, and a national study by Jenkins and Boswell (2002) revealed that over half of community college students require some remedial coursework. Lack of rigorous academic coursework at the secondary level contributes to students' inability to enter college ready to engage in college-level studies. In various studies, Adelman (1999, 2005, 2006) found that advanced secondary academic courses were significant predictors of community college readiness and persistence, and attainment of an associate degree. His 2005 study concluded that, with respect to college freshmen course-taking, a few missteps could contribute to missed opportunities for students to take sequences of college-level English and mathematics. He recommended a balance of CTE and liberal arts and sciences courses for degree completion.

Adelman's (2006) *The Toolbox Revisited* study showed the prevalence of remedial course-taking among entering college freshmen, but he dispelled the notion that remediation necessarily penalizes student progress toward the degree. In this study and others cited in his report, Adelman noted that students pursuing academic programs of study who enrolled in some remedial coursework completed community college associate degrees and transferred to bachelor's degree programs at rates similar to non-remedial students. Citing Bettinger and Long (2005), Adelman suggested that "evidence that students who successfully pass through remedial coursework gain momentum toward degrees is beginning to build" (p. 54). These studies do not diminish the importance of secondary students preparing for college by taking advanced coursework, but they do suggest that some remedial coursework need not doom community college students to failure. Indeed, recent research by Calcagno et al. (2006) shows that remedial course-taking is especially problematic for younger college students, and they urge middle schools and high schools to provide "intensive supports" to help students to take and pass "gatekeeping" college preparatory courses in math (p. 27).

Postsecondary Persistence, Certificate and Degree Completion, and Transfer. Serious concern exists for student persistence in CTE programs offered by community colleges because many students enter and leave these programs after earning a few credits and acquiring short-term skills for the labor market. Though less prevalent, Grubb (1999), Silverberg et al. (2004), and Adelman (2005) reported economic benefits for postsecondary CTE students who complete credentials, including certificates as well as associate degrees. Consistently, results of these studies show economic gains for students who obtain employment related to their field of study, with the highest gains for women and minorities.

Moreover, Adelman (2005) showed that community college CTE experiences have a positive effect on moving students towards completing a four-year degree, raising student expectations of earning a bachelor's degree. Cautioning against too much emphasis on CTE enrollment, his research also revealed that when a community college student's course of study included over 65% CTE courses, degree completion dropped. For community college students wishing to pursue a four-year degree, Adelman proposed college-level math, continuous enrollment without course withdrawals and remediation, and earning credits during summer semesters. He concluded that credentials and degree completion are more important to job stability and salary earnings than credit accumulation. CTE associate degree completers demonstrated a high level of congruence between course of study and employment in that 61% were employed in jobs related to their major.

Postsecondary CTE programs are sometimes described as sub-baccalaureate wherein a four-year degree is not necessary for entry into the workforce with certification or an associate degree (see, for example, Grubb, 1999). Townsend (2000) asserts that thinking of postsecondary CTE as sub-baccalaureate is a misnomer, since technical-degree programs increasingly offer students the opportunity to transfer to the university level for a bachelor's degree. Sunderman (2006) confirmed that the transfer of both CTE coursework and occupational degrees are on the rise nationally. Her recent national study involving the State Higher Education Executive

Officers (SHEEO) association revealed that 31 of 40 states offered at least one pathway to articulate the AAS to the baccalaureate degree. She concluded that an increasing number of states are offering more sophisticated occupational transfer agreements.

Implementation

Because career pathway programs are relatively new, there is limited literature addressing implementation; however, research on related reforms provides clues as to what can be expected for career pathway programs. Orr (2000) studied the implementation of career-focused high school-to-college transition programs associated with the School-to-Work Act and tech prep and reported that the number of partners, state policy interpretation, educational leadership, and multiple opportunities for partnerships influenced the nature and intensity of collaboration and implementation. Partnerships involving one or two school districts aligned with a community college district created more substantive collaboration than partnerships of multiple community colleges and districts. State interpretation of federal funding streams like tech prep influenced program areas, service models, and delivery. Further, she found little comprehensive structural change associated with school-to-work and tech prep except at the secondary level and even then, many programs were implemented piecemeal. Orr's research called attention to difficulties inherent in systemic collaboration, noting that programming rarely includes systemic 2+2 articulation agreements of the sort advocated for CTE transition or career pathway programs.

Rosenbaum (1999, 2002) concurred that challenges to student transition rest not only with practices implemented within institutions, but also with program failures and ineffectiveness in the ways in which institutions act or fail to act with each other. Collaboration and program alignment play important roles in student performance, including transition. He recommended that high schools and community colleges enhance their effectiveness and meet their students' needs by encouraging ongoing dialogue regarding college expectations and the challenges associated with college completion, labor market demands and workforce trends, and pre-collegiate assessment of student performance prior to the senior year of high school. Open lines of communication involving students, parents, educational institutions, and business are vitally important to implementation. Rosenbaum claimed that community colleges should encourage 2+2 articulation agreements between secondary and postsecondary institutions and share student degree completion data related to high school students' GPAs and test scores.

Other scholars have considered challenges to implementation of high school-to-college transition programs involving CTE and dual credit (see, for example, Johnstone & Del Genio, 2001). Questions exist regarding the quality of coursework and program accountability, the loss of students who take courses on college campuses rather than at their high schools, and complications with the transfer of credits. Another concern has to do with equity in program access—minority and economically disadvantaged students have displayed limited participation relative to non-minority students (Clark, 2001). A related equity issue was raised by Bragg et al. (2002): tech prep programs served a disproportionate number of males, a finding attributed to the heavy emphasis on technical occupations historically associated with males.

Knowledge regarding program effectiveness remains elusive because of limited research about whether programs actually increase access to college, result in reduced remedial coursework, and prepare students for further education and employment (Barnett, Gardner, & Bragg, 2004; Catron, 2001; Peterson, Anjewierden, & Corser, 2001; Puyear, Thor, & Mills, 2001). Due to the time and money required to conduct longitudinal studies, comprehensive third-party evaluations tracking students from high school to college are extremely rare (Carriuolo, 1996). Data are usually collected via a short survey instrument drafted by a partnering institution aimed at gathering perceptions of quality by various stakeholders. Without more objective and credible evidence of effectiveness, it is difficult to know whether transition programs are working, how these programs influence student transition to college, and how students subsequently perform in postsecondary coursework and employment. Bailey and Karp (2003) concur with Carriuolo's observation, stating that no definite conclusions can be drawn from the existing literature because of inappropriate and inadequate research designs. Specifically, they observed that most studies of high school-to-college transition programs fail to control for students' pre-existing characteristics, making it difficult to determine whether these programs have an effect over and above student background and previous educational experiences.

Method

The CTE Pathway Transition Programs study utilized a mixed method design (Creswell, 2003) to compare outcomes of participation and non-participation in CTE transition programs at the secondary and postsecondary levels. The Academy for Educational Development (AED) assumed responsibility for the study of secondary school participation in CTE transition programs, and the University of Illinois at Urbana-Champaign (UIUC) took the lead on the postsecondary segment of the study. The secondary component of the study examined differences in academic achievement and transition to college and careers among CTE participants and non-participants in health and IT/CIS fields. With respect to the postsecondary component of the study, the transition pathways and related experiences of postsecondary students transitioning from high school CTE transition programs to a local community college were studied retrospectively to determine student progress through the community college and into further education and employment.

Student participants were selected systematically, ensuring that CTE program participants exhibited characteristics similar to comparison student groups. At the secondary level, CTE program participants were matched with a comparison group of non-participants in the same school to increase the likelihood of demographic and academic similarities. At the community college level, several student groups were included in order to study the impact of the transition experience on postsecondary participation and outcomes. These groups included students who participated in the specified CTE transition programs, compared to students who did not participate in the programs and those from high schools that were more and less engaged in these transition programs. (Further detail on student participants is provided in Chapters 2 and 3.)

Consistent with the mixed method design, this study involved both qualitative and quantitative data. The quantitative segment examined the impact of participation in a CTE transition program on students' academic achievement and transition to college, as measured by students' transcripts, attendance records, and survey data. The qualitative component of the study explored secondary and postsecondary perspectives with respect to core CTE transition practices thought to influence student outcomes. Additional qualitative data were collected from secondary students who participated in CTE transition programming to provide insight into student experiences in such programming and its perceived effect, if any, on academic achievement and preparation for college and career.

During the summer and fall of 2003, AED and UIUC research team members engaged in site selection activities, including investigating and collecting preliminary descriptive data through site visits, document reviews, and interviews of site participants. An important focus of the site search was evidence of a high level of implementation of the health and IT/CIS career pathways, two occupational sectors important to the U.S. economy. Both industries are identified as high growth and high demand occupational areas on the national level (see, for example, Bureau of Labor Statistics, 1999, 2002-03). Two community colleges were selected as primary units of study for the CTE Transition Program study after considerable review and deliberation. The research site implementing the health transition curriculum is located in the Southeast region of the United States, the IT/CIS curriculum site in the Northwest.

In the Southeast site, a community college that formed part of an Emergency Medical Technologies (EMT) transition network was recruited because it was the recipient of the *Sharing What Works "Exemplary" Postsecondary CTE Award* in 2002. It was recognized for offering dual-credit curriculum and sustaining strong partnerships with community partners. The original design of the study called for the selected community college to identify high schools that were engaged in the CTE transition pathway program to differing degrees. Community college administrators experienced difficulties in identifying less engaged high schools, but ultimately the secondary school component of the study included three high schools, a regional technical center, and a primary community college offering health programs in the Health Alliance Pathway. The postsecondary component of the study included the primary community college and eight high schools, four of which comprised the total number offering the EMT-Basic transition pathway program, and four of which were comparison high schools offering health non-transition programs. Referrals from regional CTE administrators were used to assist the research team in locating the comparison high schools.

In the Northwest site, a CTE transition program, the recipient of a *2003 National Star of Education Award,* was identified and recruited to participate. Although it had not been named a promising or exemplary program by the *Sharing What Works* project, it was recommended by numerous state and local practitioners knowledgeable about similar programs. Despite difficulties recruiting less engaged schools, two high schools in a school district less engaged in the CTE transition pathway program ultimately agreed to join three high schools associated with a more highly engaged school district. Therefore, the secondary component of the study included five high schools at the Northwest site, an intermediary organization that offered transition services and facilitated partnerships involving education and business in support of student transition to college and career in the county, and a community college.

For the postsecondary component of the study, the institutional sample consisted of the primary community college and the upper-division university mentioned above, plus 25 high schools selected using a systematic sampling procedure. The sample consisted of students whose last high school of attendance was one of 25 high schools selected from the 52 feeder secondary schools into the primary community college under study. All selected schools had articulation agreements with the community college through the intermediary organization; 10 had IT/CIS articulation agreements. Other criteria used for the purpose of sampling the high schools were ethnic and socioeconomic group membership and level of school engagement in the IT/CIS dual credit program offered through the intermediary organization.

Institutional level of engagement is an important variable in this study, given the distinct structure of programming and operational procedures associated with the two sites. At the Northwest IT/CIS site, the secondary component of the study employed a global measure of engagement provided by the former director of an intermediary organization to compare schools high or medium engaged in the CTE transition program. The postsecondary component of the study used the same global measure to compare schools highly or less engaged in the CTE transition program, but added to and focused the analysis on the number of IT/CIS articulation agreements in the engagement index.

Also at the Southeast site, the postsecondary component of the study defined high engaged schools as those offering the EMT-Basic transition pathway program. Less-engaged schools did not offer the EMT-Basic transition pathway program but rather offered other health-related programs not aligned with college-credit generating coursework.

Limitations

Limitations of this study are important to recognize, beginning with differences in selection of sites for the study and therefore in selection of study participants due to the need to facilitate data acquisition and accommodate the unique goals of the secondary and postsecondary components of this study. Difficulties occurred with local administrators failing to meet obligations to provide data after showing initial interest and committing to participate in the study. Moreover, the size of subset samples was sometimes very small in the chosen sites. Concerns of privacy and the perception that data sharing might influence college admission were cited as reasons for non-cooperation by students and parents. Another limitation involved the reliance on self-report data of students' high school experiences and transition to college and employment. Input from parents, school officials, and others might have yielded useful information, though resource limitations (time and money) precluded additional data collection. A final limitation having enormous consequence to the study involved the researchers' inability to carry out a longitudinal study of the sort most appropriate to measure student matriculation patterns over time. (See Appendix A for a more in-depth discussion of the limitations of this study.)

Organization of the Report

This research report on CTE transition programs and student outcomes is organized into four chapters. This chapter has introduced the CTE transition pathway study, including the purpose of the research; a literature review; methods, including procedures for site selection and acquisition of the study sample; and limitations. Chapter 2 highlights results pertaining to two selected secondary CTE transition programs. Findings of the relative effects of CTE participation as they relate to the student outcomes of academic achievement and transition to college and career are presented. Chapter 3 summarizes outcomes based on former student participation or non-participation in selected secondary CTE transition pathway programs; secondary institution level of engagement in the CTE transition programs is also examined. Chapter 4 synthesizes findings across the secondary and postsecondary components of the study. The relative effects of CTE practices on student participants' academic achievement and transition to and success in college are described. Recommendations for improving CTE transition programs, practices, and policies conclude the report.

CHAPTER 2: PARTICIPATION IN SECONDARY CTE TRANSITION PROGRAMS, HIGH SCHOOL PERFORMANCE, AND TRANSITION TO COLLEGE AND CAREER

This chapter presents findings on high school performance and the transition to college and career for participating CTE and non-CTE high school students. The methods used and the secondary level information technology (IT[3]) and health career pathway programs studied are first described. The quantitative findings on high school performance and the transition to college and career are then examined. The study looked at the effectiveness of CTE transition pathway programs in providing secondary students with an integrated CTE and academic education, supporting successful student transition from secondary to postsecondary education, and preparing young people for successful careers. The research questions were as follows:

1. What is the effect of participation in secondary CTE transition programs on students' high school performance and transition to college and career?
2. How are particular practices (e.g., dual credit) implemented at the secondary level and what is their perceived relationship to student transition behavior and student outcomes? How do these practices differ depending on the high school CTE program?
3. What is the effect of school engagement in CTE transition programs on students' high school performance and transition to college and career?

Method

A mixed method approach was used to compare outcomes of participation versus non-participation in CTE transition programs at the secondary level. During the 2003-04 academic year, two site visits at each participating high school—including interviews, focus groups, and document collection—were conducted. Interviewees were students, instructors, guidance counselors, and administrators. To assess the impact of high school CTE transition programs on academic performance and transition to college and career, the effects of participation in CTE and high school engagement level were examined. These variables are described below.

Variables

Participation in CTE. CTE students were 12th grade students who had completed a health program in the Southeast site or an IT program of study in the Northwest site. Health students had participated in an EMT-Basic transition pathway or a PCA career cluster program during their junior or senior year of high school. IT/CIS students had taken a minimum of three IT classes during their high school career. Non-CTE students were 12th grade students who had not participated in a CTE program, although they may have taken some CTE classes. For the health and IT programs, school liaisons identified this comparison group by individually matching CTE students to students who had not participated in a CTE program by high school, gender, racial/ethnic background, age, and GPA within a half a point. When available, students' socioeconomic status (SES) was also used as a matching variable.

3 *IT* is used to refer to secondary school level Information Programming. In the other chapters of this report, the term *IT/CIS* is used to refer to the Information Technology/Computer Information Sciences postsecondary pathway.

School Engagement in the CTE Transition Program.[4] In the Northwest IT site, the director of an intermediary organization fostering partnerships among secondary and postsecondary education, business, and community institutions rated the level of engagement of secondary schools in the county on a 4-point scale (1 = None, 2 = Low, 3 = Medium, and 4 = High). In rating the schools, the director considered measures based on an analysis of data collected from partnering secondary schools. The selected measures included dual credit enrollment for the current and previous years, average participation rate of the school districts and individual schools, use of products and services (e.g., dual credit flyers, bookmarks, calendars, videos and CDs, postcards, and posters) for the current and previous years, and participation in governing board meetings for the present year. Using these measures, the director identified the three high schools in one participating district as high engaged and the two high schools in the other participating district as medium engaged.

Academic Performance. Academic performance was assessed using a standardized achievement test, the ACT WorkKeys assessment, and students' GPA as reported on their high school transcripts. The Applied Mathematics and Reading for Information subtests of the ACT WorkKeys assessment were administered in the spring of the participants' senior year of high school. High school transcripts for all participating students were collected following their graduation from high school. Courses offered at the eight participating high schools were coded into four broad categories of academic, CTE, military, and other. Math and science courses were further coded into high, medium, and low difficulty (see Appendix D).

Transition to College and Career. A high school exit survey based on information collected during the initial site visit was designed to assess students' perspectives on their high school education, the transition to college, and their plans for college and careers. A follow-up survey was designed to determine participants' transition to college and preparation for college and career six months following graduation from high school.

Data Analysis

For all quantitative analyses, only those CTE students matched to non-CTE students were included. For transcript, standardized test, and scaled survey item analyses comparing CTE students to non-CTE students, paired samples *t* tests were conducted. For comparisons examining the effects of CTE status and school engagement level, repeated measures analyses of variance were conducted. The tests compared CTE students to their matched non-CTE counterparts, with school engagement as a between-subjects factor. For all comparisons of categorical survey items, the McNemar chi-square test for paired data was used. For each set of quantitative analyses, the overall differences between CTE students and their matched non-CTE counterparts was first examined, followed by the effect of school engagement in the Northwest site. School engagement was not assessed in the Southeast site, where the EMT and PCA programs were offered at the same schools.

Secondary Student Sample

The total sample for the secondary school component of the study was 136 students, with 68 CTE students (32 IT students in the Northwest site and 36 health students in the Southeast site) and their matched counterparts. Table 1 presents the demographic data for CTE students and

4 Students from the Southeast health site were not included in these analyses because the engagement level of schools could not be assessed.

their matched non-CTE counterparts. As reported, most of the sample was Caucasian and there was a balance of male and female participants.

Table 1.
Race/Ethnicity and Gender for CTE and Non-CTE Students

	CTE Students %	Non-CTE Students %
Race/Ethnicity (*N* = 136)		
Caucasian/White	82.3	85.2
Asian American/Pacific Islander	10.3	7.4
African American/Black	5.8	5.8
Latino/Hispanic	0.0	1.5
Native American	1.5	0.0
Gender (*N* = 136)		
Male	52.9	52.9
Female	47.1	47.1

A sub-sample of Northwest IT students and their matched counterparts was used to examine the effect of school engagement. Table 2 presents the demographic data for the IT students at high and medium engaged schools and their matched counterparts.

Table 2.
*Race/Ethnicity and Gender for IT and Matched Non-IT Students at High and Medium Engaged Schools (*N *= 62)*

	IT High Engaged % (*N* = 19)	Matched High Engaged % (*N* = 19)	IT Medium Engaged % (*N* = 12)	Matched Medium Engaged % (*N* = 12)
Race/Ethnicity				
Caucasian/White	89.5	94.7	66.7	75.0
Asian American/Pacific Islander	10.5	5.3	16.7	16.7
African American/Black	0.0	0.0	8.3	8.3
Native American	0.0	0.0	8.3	0.0
Gender				
Male	84.2	84.2	75.0	75.0
Female	15.8	15.8	25.0	25.0

CTE Transition Programs in the Northwest and Southeast Sites

Northwest Information Technology Career Pathway Program

As a rapidly growing sector in the U.S. economy and a critical part of the Northwest site state's economic activity, information technology (IT) is an important area for career preparation. An intermediary organization established in 1999 played a key role fostering relationships between education and businesses within the county under study. This organization facilitated partnerships among four community and technical colleges and 33 high schools within the county. Their mission, as described in a brochure, was to promote relationships among education, business, labor, government, and other organizations in order to foster significant career and learning experiences for the current and future workforce. Through these partnerships, it coordinated the career pathway, dual credit, and work-based learning practices, implemented in different ways and to different degrees in the county's high schools.

The secondary schools in the county under study offered five career pathways: Arts and Communication, Business and Marketing, Engineering and Technology, Health and Human Services, and Science and Natural Resources. The IT course sequences were included under three of these pathways. In each pathway there were program majors that students could follow. For example, in the Engineering and Technology pathway, a student could major in the Programming and Software Development program by taking Introduction to Programming, Oracle Internet Academy I, and Oracle Internet 2. Following the recommendations of an IT skills panel, an articulated secondary gateway IT class named Fundamentals of IT was instituted. The intermediary organization identified articulated IT transition pathways from the secondary level to two-year colleges to the bachelor's degree level. To illustrate, a student who took Fundamentals of IT, Computer Support, and Introduction to Programming in high school could continue in Application Programming at one of the four partnering two-year colleges and then transfer to a four-year institution and earn a bachelor's degree in Computer Science.

Five high schools offering IT programming participated in the study. The three high schools rated as high engaged had adopted career pathways. Students began exploring potential career areas in junior high school, and incoming high school students were expected to select one of the five career pathways. The course guides for the three high engaged district schools were organized by the five career pathways, making it easier for students to select classes in their chosen career pathway. In addition, for each pathway, the course guides described sequences of courses leading to program majors. The Fundamentals of IT gateway IT class was offered at all three high schools and the sequences of IT courses were presented to students in the course guides and in career pathway honors applications. As an incentive for completing a sequence of classes in a career pathway, students were awarded an honor cord at the graduation ceremony.

In contrast to the schools described above, the two participating high schools rated as medium engaged had not fully implemented career pathways at the time of the study. Unlike the course guides of the high engaged schools, the course guides of the medium engaged schools were not clearly organized into course descriptions by career pathway. Students tended to be informed about IT course offerings through "word of mouth." Administrators explained that following the implementation of pathways, the school's focus shifted to academics and standardized testing, moving away from the career pathway model. This change was driven by federal and state policies and the need for the district to improve its scores on standardized tests.

According to the director of the intermediary organization, the high engaged schools were more actively involved in the process of establishing articulation agreements between the secondary and postsecondary institutions than the medium engaged schools: "[The high engaged] school district mandates that CTE courses be articulated whenever possible." She also stated that the district was represented at every articulation meeting. The director attributed the active involvement of the faculty in the process of developing the articulations to the high level of support from the district leadership, "starting with the superintendent, all the way down." A table summarizing findings from qualitative site visits at the high and medium engaged schools is presented in Appendix B.

Southeast Health Career Programs

Health careers, the second area under study, represent the largest industry in the United States, with increasing occupational growth projected. Two health career programs were examined in this study, an Emergency Medical Technician (EMT) program and a Patient Care Assistant (PCA) program, in one school district in a Southeast state where health is the leading industry. The EMT program under study had articulated agreements that provided students with opportunities to receive both high school and college credit while acquiring technical skills through career exploration. In contrast, PCA offered students career exploration opportunities but no formal dual credit arrangements.

PCA instruction took place at a technical center, an institution falling under the jurisdiction of the K-12 system. PCA students could receive course credit at their high schools and credit hours at the technical center. Instruction was provided by certified nurses who were also responsible for supervising students during their clinical rotations. Students who completed the 290-hour PCA cluster program could continue at the technical center in other health areas such as nursing, dental technician, or phlebotomy. However, due to Board of Nursing regulations within the county under study, PCA certification was not part of a formal sequence leading to Licensed Practitioner Nurse (LPN) or Registered Nurse (RN) programs. The technical center was open to junior and senior high school students, high school dropouts, and adult learners. Students could also transfer their credit hours to a regional community college that had informal course credit agreements with the technical center.

The Emergency Medical Technician-Basic (EMT-B) program was a one-semester, 250-hour program offered through a regional two-year community college with the only state-approved Emergency Medical Service (EMS) training center in the southwest of the state. The program was accredited by the Committee on Accreditation of EMS Programs. The EMT-B was taught by former or practicing paramedics. The goal of the high school EMT-B program was to prepare students for the postsecondary EMT-P program, leading to certification as paramedics. The curriculum included medical terminology, emergency medical care, management of trauma, lab instruction, clinical rotations of emergency rooms, and field internships. Students could follow a sequence of courses beginning in high school and continuing at the community college, leading to a postsecondary degree. Alternatively, students who completed the program and passed the certification exam could enter the workforce as state-certified Emergency Medical Technicians. A table summarizing findings on the EMT and PCA programs from qualitative site visits is presented in Appendix C.

Transition Practices

Students were asked a series of questions on the exit survey to determine their level of participation in transition practices. The identified transition practices are those initiatives thought to be important in facilitating the transition to college and career.

Contextual Learning

As reported in Table 3, paired samples *t* tests revealed statistically significant differences between CTE and non-CTE students in the degree to which their high school programming had included contextual learning. As participants in CTE transition programs, CTE students rated the contextual learning survey items higher than their non-CTE counterparts. When asked what helped students stay engaged in school, an IT instructor in the Northwest site answered “interesting, fun, relevant curriculum” and explained that as a vocational education instructor, he has this opportunity because “it’s all hands-on; it’s stuff you’re going to use in the real world.” Likewise, the EMT transition pathway program offered contextual learning opportunities in its curriculum, such as finding actors to play the part of critically ill patients whom the students had to evaluate and assist.

Table 3.
Paired Samples T *Test for Contextual Learning Ratings for CTE and Non-CTE Students*

	CTE *M* (*SD*)	Non-CTE *M* (*SD*)	*t*	*df*	*p*
What I’ve learned in school is relevant to the world outside of school	3.61 (.99)	3.11 (1.14)	3.09	65	.003**
My junior and senior year courses emphasized understanding information and its meaning	3.74 (.87)	3.30 (1.05)	2.67	65	.010*
My high school instructors placed academic content in a real life situation	3.53 (1.04)	3.02 (.98)	3.05	65	.003**

*$p < .05$, **$p < .01$, ***$p < .001$

Work-Based Learning

McNemar’s chi-square test used to determine the relationship between CTE status and participation in an internship revealed a significant result, $p = .012$. CTE students (36.7%) were more likely than non-CTE students (15.9%) to report that they had participated in an internship. There were no statistically significant differences between the two groups on participation in a job shadow, a school-based enterprise, or a work-based learning class. The lack of significant differences may have been due to an integrated CTE and academic curriculum offered at some of the schools under study, where work-based learning activities were offered to all students.

At the high engaged schools, job shadowing is a structured part of the curriculum. All students are encouraged to do a job shadow as part of their culminating project graduation requirement. In the secondary student sample, 68.4% of IT students and 77.8% of their matched non-IT counterparts reported having participated in a job shadow. In contrast, at medium engaged high schools, only 40.0% of IT students and 8.3% of their matched non-IT counterparts reported participating in a job shadow. In addition, all students at the high engaged schools have an opportunity to participate in a school-based enterprise. Each year, one of the three high engaged schools hosts Business Week, in which regular classes are suspended and business leaders engage students in entrepreneurship projects. In the secondary student sample, 61.1% of non-IT students and 47.4% of their IT counterparts indicated that they had participated in a school-based enterprise, whereas 20.0% of IT students and 8.3% of their non-IT counterparts at medium engaged schools reported that they had participated in a school-based enterprise.

Mentoring

McNemar's chi-square test conducted to determine the relationship between CTE status and whether or not students had a mentor during high school indicated a statistically significant result, $p = .011$. CTE students (40.6%) were more likely to report having had a mentor during high school than non-CTE students (20%).

Like job-shadowing described above, mentoring is a structured part of the curriculum at high engaged schools. All students are required to find a mentor to supervise their community experience, one of the components of the culminating project. Students are responsible for identifying a person in the community who has expertise in their chosen area and initiating and establishing a relationship in which they work closely together. Among the students at high engaged schools, 78.9% of IT students and 52.6% of their matched counterparts reported having had a mentor in high school. In the medium engaged schools, there are no formal mentoring initiatives; 18.2% of IT students at medium engaged high schools and none of their matched counterparts reported having a mentor during high school.

Industry Certification

McNemar's chi-square test performed to determine the relationship between CTE status and whether or not students took an industry certification exam revealed a significant result, $p = .000$. As expected, more CTE students (34.8%) than non-CTE students (3.3%) reported that they had taken an industry certification exam. In addition, more CTE students (33.3%) than non-CTE students (3.3%) indicated that they plan to take a certification exam, $p = .000$. CTE students, therefore, had an increased likelihood of gaining industry certification and viable employment. The CTE transition programs studied offered opportunities for industry certification, but not all participants elected to earn certification, choosing instead to continue in the career pathway during postsecondary studies.

Dual Credit

McNemar's chi-square test conducted to determine the relationship between CTE status and participation in dual credit revealed that CTE students (66.7%) were significantly more likely to have participated in at least one dual credit class than non-CTE students (30.2%), $p = .000$. The EMT program and the IT programs at the high engaged schools offered opportunities for secondary students to earn dual credit at a community college. At the high engaged schools, there is a commitment to making school work relevant to the world outside of school by offering industry certification and dual credit with a community college for all of the career pathway courses. Among students in the Northwest site, 78.9% of IT students at high engaged schools, 25.0% of IT students at medium engaged schools, 21.1% of non-IT students at high engaged schools, and .1% of non-IT students at medium engaged schools reported participating in at least one dual credit class.

High School Performance

High School Course-Taking

Paired samples *t* tests revealed statistically significant differences between CTE students and non-CTE students on the number of CTE courses that they took during high school [$t\ (66) = 3.45$, $p < .001$], the cumulative CTE credits that they earned [$t\ (66) = 4.29$, $p < .000$], and the number of dual credit courses that they took [$t\ (25) = 2.73$, $p < .011$]. Confirming their group status, CTE students took significantly more CTE courses (*M* = 10.43, *SD* = 3.32) than their non-CTE counterparts (*M* = 8.28, *SD* = 3.93) and earned significantly more CTE credits (*M* = 5.94, *SD* = 1.90) than their non-CTE counterparts (*M* = 4.55, *SD* = 2.15). CTE students also took significantly more dual credit courses (*M* = 5.54, *SD* = 2.58) than their matched non-CTE counterparts (*M* = 4.00, *SD* = 2.08). Given that they spend more time in CTE classes, it is notable that there were not any significant differences between CTE and non-CTE students in their academic course-taking. This may be due to the increased focus of CTE programming on college preparation and the integration of CTE and academics.

The interaction between CTE status and school level engagement was statistically significant for the mean number of math credits earned, as reported in Table 4. IT students in medium engaged schools earned more mean math credits (3.77) than their non-IT matched counterparts (2.59). However, IT students (3.20) and non-IT students (3.23) in high engaged schools had comparable results.

Table 4.
Repeated Measures Analysis for Mean Math Credits Earned for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.013	1	.013	.013	.910	.000
CTE Status	4.749	1	4.749	11.073	0.002**	0.276
Status x Engagement	5.168	1	5.168	12.050	0.002**	0.294
Error (Engagement)	30.091	29	1.038			
Error (CTE)	12.437	29	.429			

As reported in Table 5, interaction effects for science course-taking were also statistically significant, with IT students at medium engaged schools earning 3.04 mean science credits compared to their non-IT matched counterparts earning 2.09 mean science credits. By contrast, the non-IT students at high engaged schools earned 2.77 mean science credits in comparison to the IT students, who earned 2.45 mean science credits.

Table 5.
Repeated Measures Analysis for Mean Science Credits Earned for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.028	1	380.947	314.371	.000***	.916
CTE Status	1.406	1	1.406	3.094	.089	.096
Status x Engagement	5.810	1	5.810	12.780	.001**	.306
Error (Engagement)	35.141	29	1.212			
Error (CTE)	13.182	29	.455			

The pattern of math and science course-taking at the high and medium engaged schools indicates that there was a greater disparity in the amount of math and science courses taken between IT and non-IT students at the medium engaged schools than at the high engaged schools. Through whole school reform at the high engaged schools, all students were encouraged to integrate their academic course-taking with their career pathway. In contrast, the medium engaged schools had not formally implemented career pathways. At these schools, the IT students may have been more likely to receive guidance to take math and science courses through their participation in CTE, whereas the non-IT students did not have such an opportunity.

High School Achievement

There were no significant differences in students' academic achievement measured by students' overall high school GPA, math GPA, and science GPA. Students who pursued a health or an IT career pathway in high school performed academically as well as those who did not pursue a CTE area. However, a paired samples *t* test revealed a statistically significant difference between CTE students and non-CTE students on the ACT WorkKeys Reading for Information sub-test [$t\ (67) = 3.02$, $p < .004$]. CTE students ($M = 5.00$, $SD = 1.07$) scored significantly higher than non-CTE students ($M = 4.54$, $SD = .91$). There was no effect of CTE status on the ACT Applied Mathematics sub-test and there was no effect of school engagement on ACT scores.

High School Preparation for the Transition to College and Career

Information on Course-Taking and the Transition to College and Career

Participants were asked whether high school had provided them with information on high school courses and their relationship to career areas and college programs. A paired samples *t* test revealed that CTE students ($M = 3.76$, $SD = .95$) rated the degree to which they had received enough information on their high school courses and how they relate to different career areas higher than their non-CTE counterparts ($M = 2.98$, $SD = .97$) [$t\ (65) = 4.48$, $p < .000$]. Likewise, CTE students ($M = 3.71$, $SD = 1.08$) rated the degree to which they felt that their high school had provided information on college courses and programs that follow their high school courses higher than their non-CTE counterparts ($M = 3.08$, $SD = 1.17$) [$t\ (65) = 3.22$, $p < .002$]. These findings indicate that, according to students' self-report, the CTE transition programs under study were meeting their goal of providing students with a seamless transition from their high school CTE program into a postsecondary career. Both the EMT program and the IT programs at the high engaged schools offered clear sequences of courses from the secondary to the postsecondary level.

Career and Educational Goals and Plans

Students were asked a series of questions on their goals and plans for their education and their career. Paired samples *t*-tests revealed differences in the degree to which CTE students and their matched non-CTE counterparts felt that they had goals and plans at the end of high school. As reported in Table 6, CTE students rated four of the six items higher than their non-CTE counterparts. CTE students rated the degree to which they had a plan for achieving their academic goals significantly higher than non-CTE students. CTE students were also significantly more likely than their matched non-CTE counterparts to report having a plan to pursue a career and an education in their CTE area, and a clear career goal.

Table 6.
Paired Samples T *Test for Goals and Plans Ratings for CTE and Non-CTE Students*

	CTE *M* (*SD*)	Non-CTE *M* (*SD*)	*t*	*df*	*p*
I have a plan for the year after I graduate	4.62 (.67)	4.52 (.95)	.75	65	.457
I have a long-term plan to achieve my career goals	4.55 (.75)	4.24 (1.02)	1.97	65	.054
I have a plan for achieving my academic goals following high school	4.52 (.61)	4.17 (1.03)	2.42	65	.018*
I plan on pursuing a career in the (computer or health) field	4.35 (1.00)	2.12 (1.41)	11.48	65	.000**
I plan on continuing my studies in the (computer or health) field	4.38 (.96)	2.11 (1.42)	12.03	65	.000**
I have a clear career goal	4.38 (.92)	3.91 (1.12)	2.83	65	.006**

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Development of Skills

Paired samples *t* tests were conducted to determine whether, at the end of high school, CTE and non-CTE students differed in the degree to which they felt they had developed skills during high school. Students were asked about twelve skills important to success in college and the workplace. As reported in Table 7, for nine of these skills, CTE students rated the degree to which they had developed these skills significantly higher than did their non-CTE counterparts.

Table 7.
Paired Samples T *Test for Skill Ratings for CTE and Non-CTE Students*

Skills	CTE *M* (*SD*)	Non-CTE *M* (*SD*)	*t*	*df*	*p*
1. Problem-Solving	4.03 (.68)	3.47 (.81)	4.73	65	.000***
2. Ability to Complete Projects	4.14 (.74)	3.83 (.89)	2.19	65	.032*
3. Teamwork	4.18 (.93)	3.91 (.92)	1.78	65	.080
4. Conduct Research	4.17 (.89)	3.77 (.97)	2.67	65	.010*
5. Math	3.86 (1.04)	3.38 (1.21)	2.61	65	.011*
6. Reading and Writing	4.06 (1.01)	3.83 (1.02)	1.39	65	.171
7. Applying to College	3.61 (1.05)	3.20 (1.13)	2.23	65	.029*
8. Work-Related Skills	3.94 (.98)	3.24 (1.10)	3.89	65	.000***
9. Communication	4.15 (.88)	3.70 (1.01)	2.67	65	.010*
10. Time Management	3.91 (1.08)	3.50 (1.08)	2.12	65	.038*
11. Organizing Ideas	3.97 (.91)	3.67 (.93)	1.97	65	.054
12. Thinking Critically	4.14 (.74)	3.59 (.94)	3.53	65	.001**

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Repeated measures analyses of variance revealed interaction effects for five of the twelve skills. As reported in Tables 8 through 15, for problem-solving, communication, and organizational skills, CTE students at medium engaged schools reported that they had developed these skills to a greater extent than did CTE students and non-CTE students at high engaged schools, who tended to rate these skills at similar levels. Finally, non-CTE students at medium engaged schools rated these skills lower than the other three groups. Through the career pathway programs at the high engaged schools, both CTE and non-CTE students were given opportunities to develop their communication, problem-solving, teamwork, and organizational skills. For example, both groups of students had to present their culminating project and their future career and education goals to a group of community businesspeople. This may be why they rated these skills at similar levels. In contrast, the non-CTE students at medium engaged schools did not have opportunities that the CTE students had as part of their participation in the IT programs, such as work-based and contextual learning.

Table 8.
Repeated Measures Analysis for the Development of Problem-Solving Skills for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.097	1	.097	.239	.629	.008
CTE Status	6.156	1	6.156	14.832	.001***	.338
Status x Engagement	2.801	1	2.801	6.749	.015*	.189
Error (Engagement)	11.774	29	.406			
Error (CTE)	12.037	29	.415			

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 9.
Mean Ratings (and Standard Deviations) for the Development of Problem-Solving Skills for CTE and Non-CTE Students at High and Medium Engaged Schools

	CTE Students	Non-CTE Students
High Engaged School	3.88 (.70)	3.68 (.58)
Medium Engaged School	4.25 (.87)	3.17 (.39)

Table 10.
Repeated Measures Analysis for the Development of Communication Skills for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.087	1	.087	.124	.727	.004
CTE Status	4.386	1	4.386	5.681	.024*	.164
Status x Engagement	7.289	1	7.289	9.442	.005**	.246
Error (Engagement)	20.30	29	.700			
Error (CTE)	22.388	29	.772			

$^*p < .05$, $^{**}p < .01$, $^{***}p < .001$

Table 11.
Mean Ratings (and Standard Deviations) for the Development of Communication Skills for CTE and Non-CTE Students at High and Medium Engaged Schools

	CTE Students	Non-CTE Students
High Engaged School	3.79 (.92)	3.95 (.78)
Medium Engaged School	4.42 (.67)	3.17 (1.03)

Table 12.
Repeated Measures Analysis for the Development of Time Management Skills for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.113	1	.113	.177	.677	.006
CTE Status	5.546	1	5.546	4.320	.047*	.130
Status x Engagement	7.611	1	7.611	5.929	.021*	.170
Error (Engagement)	18.596	29	.641			
Error (CTE)	37.228	29	1.284			

*$p < .05$, **$p < .01$, ***$p < .001$

Table 13.
Mean Ratings (and Standard Deviations) for the Development of Time-Management Skills for CTE and Non-CTE Students at High and Medium Engaged Schools

	CTE Students	Non-CTE Students
High Engaged School	3.53 (.90)	3.63 (.96)
Medium Engaged School	4.33 (.89)	3.00 (1.21)

Table 14.
Repeated Measures Analysis for the Development of Organizational Skills for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.246	1	.246	.267	.609	.009
CTE Status	2.421	1	2.421	3.450	.073	.106
Status x Engagement	3.840	1	3.840	5.472	.026*	.159
Error (Engagement)	26.721	29	.921			
Error (CTE)	20.353	29	.702			

*$p < .05$, **$p < .01$, ***$p < .001$

Table 15.
Mean Ratings (and Standard Deviations) for the Development of Organizational Skills for CTE and Non-CTE Students at High and Medium Engaged Schools

	CTE Students	Non-CTE Students
High Engaged School	3.53 (.90)	3.63 (.90)
Medium Engaged School	4.17 (.42)	3.25 (1.06)

As reported in Tables 16 and 17, a repeated measures analysis of variance revealed an interaction effect for teamwork. Again, CTE students at the medium engaged schools rated their development highest, followed by the non-CTE students at high engaged schools, the non-CTE students at medium engaged schools, and finally, the CTE students at high engaged schools.

Table 16.
Repeated Measures Analysis for the Development of Teamwork Skills for CTE Status (Within-Subjects Factor) by Level of School Engagement (Between-Subjects Factor)

Source	Type III Sum of Squares	*df*	Mean Square	*f*	Sig.	Partial Eta Squared
School Engagement	.936	1	.936	.854	.363	.029
CTE Status	.044	1	.044	.072	.790	.002
Status x Engagement	3.270	1	3.270	5.320	.028*	.155
Error (Engagement)	31.774	29	1.096			
Error (CTE)	17.827	29	.615			

*$p < .05$, **$p < .01$, ***$p < .001$

Table 17.
Mean Ratings (and Standard Deviations) for the Development of Teamwork Skills for CTE and Non-CTE Students at High and Medium Engaged Schools

	CTE Students	Non-CTE Students
High Engaged School	3.53 (.90)	4.05 (.85)
Medium Engaged School	4.25 (1.21)	3.83 (.72)

Transition to College and Career

College Enrollment

McNemar's chi-square test was conducted to determine the relationship between CTE status and enrollment in college. CTE students (74.5%) were as likely as their non-CTE counterparts (76.6%) to have enrolled in college in the fall following their graduation from high school—53.2% of CTE students and 40.4% of non-CTE students were enrolled in a two-year college; 21.3% of CTE students and 36.2% of non-CTE students were enrolled in a four-year college.

Continuation in CTE Pathway

CTE students were significantly more likely to be enrolled in the career area that they had studied in high school than their non-CTE counterparts, $p = .000$. Among study participants enrolled in college at the follow-up, 69.0% of CTE students and 17.5% of non-CTE students were enrolled in the target CTE area. Among respondents who indicated their major, 55.6% of IT graduates were enrolled in a computer-related major compared to less than 1% of their matched non-CTE counterparts. Of health students, 79.2% were enrolled in a health major compared to 30.0% of their matched non-CTE counterparts. A McNemar's chi-square was conducted to determine the relationship between CTE status and enrollment in one of the partnering colleges. CTE students were not significantly more likely than their matched counterparts to enroll at one of the partnering colleges under study. Among study participants enrolled in college at the follow-up, 50% of CTE students and 34.3% of non-CTE students were enrolled in the target community college. Half of the CTE students enrolled in the target community college where they had earned dual credit for their participation in the CTE program.

Remediation

CTE students were not more likely than their matched non-CTE counterparts to report requiring remediation courses in their first semester of college. Among students enrolled in college, 19.4% of CTE students and 22.2% of their matched non-CTE counterparts reported that they were required to take a math, reading, or writing course without earning college credit.

Educational Aspirations

When students were asked about their educational aspirations at the six-month follow-up, CTE students aspired as high as their matched non-CTE counterparts. Among respondents, 84.8% of CTE students and 82.2% of non-CTE students planned to earn a bachelor's degree or higher.

Table 18.
Planned Highest Level of Education for CTE and Non-CTE Students

Planned Highest Level of Education	CTE Students (%)	Non-CTE Students (%)
High School	2.2	4.4
Technical Certificate	6.5	6.7
Associate's Degree	6.5	6.7
Bachelor's Degree	41.3	51.1
Master's Degree	23.9	24.4
Doctorate	19.6	6.7

Preparation to Apply for and Get Into College

On the follow-up survey, respondents were asked to think back to when they first completed high school and rate how prepared they were to apply for and get into college. A two-way analysis of covariance revealed that students from high engaged schools ($M = 3.73$, $SD = 1.08$) felt more prepared than students from medium engaged schools ($M = 2.67$, $SD = 1.09$) [$F(1,35) = 6.41$, $p = .02$][5]. Through the career pathways, the high engaged schools attempted to blur the boundary between a CTE program of study and a college preparation program of study.

5 This analysis was done with a small sample size ($N = 40$): 9 medium engaged students and their matched counterparts and 11 high engaged students and their matched counterparts.

In contrast, at the medium engaged high schools, a distinction was made between CTE students and college preparatory students. Guidance staff reported that they placed students who were not college bound into vocational classes, including IT classes.

Employment

At the six-month follow-up, there were no significant differences in the number of CTE students and non-CTE students employed either part or full-time. However, significantly more IT students than matched non-IT students were employed at the time of the follow-up survey ($p = .017$, two tailed Fisher's exact test). Among IT students at high engaged schools, 25% were working full-time and 25% were working part-time. Among IT students at medium engaged schools, 11.1% were working full-time and 66.7% were working part-time. In contrast, none of the non-IT students at high engaged schools were working full-time and 33.3% were working part-time, while 11.1% of the non-IT students at medium engaged schools were working full-time and none of them were working part-time.

Conclusion

This chapter presented findings on the implementation of transition practices, the impact of CTE participation on high school performance and the transition to college and career, and the effect of school engagement on the relationship between CTE participation and student outcomes. Qualitative and quantitative analyses revealed differences in student participation in practices thought to facilitate the transition to college and career. Confirming their participation in an IT or health program, CTE students reported participating in more of the transition practices—such as contextual learning, work-based learning, mentoring, and dual credit—than their non-CTE counterparts. Furthermore, students who had participated in career pathways at high engaged schools were more likely to have completed a job shadow, participated in a school-based enterprise, and engaged in a mentoring relationship than students at the medium engaged schools, where career pathways had not been fully implemented. During qualitative site visits, school administrators, counselors, teachers, and students linked practices such as contextual learning and work-based learning to the successful transition to college and career. Importantly, CTE students, particularly those at high engaged schools, were more likely to have taken part in such activities.

In examining the impact of CTE participation on high school achievement, there were few differences between CTE and non-CTE students. As expected, CTE students participated in significantly more CTE classes than their non-CTE counterparts, but the two groups did not differ in their academic course-taking or their GPAs. Therefore, participation in CTE did not hinder academic course-taking or academic achievement. CTE students, however, scored significantly higher on the ACT WorkKeys Reading for Information sub-test. In addition, compared to their non-CTE counterparts, CTE students were more likely to report that they had received information on the connection between their high school course of study and college programming, to have developed clear postsecondary education and career goals, and to report having developed skills important to success in college and the workplace. An examination of the transition to college and career demonstrated that CTE students were as likely to be enrolled in college as their non-CTE counterparts, but were significantly more likely to have enrolled in their target CTE area (IT or health). Therefore, the CTE programs studied successfully transitioned participants into an IT or health program. Once in college, CTE students also aspired as high educationally as their non-CTE counterparts.

Finally, the effect of school engagement level on high school performance and the transition to college and career was examined. As described above, the implementation of the transition practices differed at high and medium engaged schools. While the medium engaged schools implemented a more traditional system of CTE programming, the high engaged schools implemented a career pathway program designed for all students to prepare them for college and increase the relevance of school by linking coursework to career areas. Interestingly, transcript analyses revealed that the IT students at medium engaged schools participated in more math and science course-taking than the IT and non-IT students at high engaged schools. Non-IT students at medium engaged schools took the least amount of math and science courses. A similar pattern was found in the self-report data, with IT students at medium engaged schools reporting their development of skills during high school higher than IT and non-IT students at high engaged schools, and non-IT students at medium engaged schools reporting their development of skills the lowest. It may be that at the high engaged schools, where both the CTE and the non-CTE students participated in the career pathway program, the two groups of students had more similar experiences than at the medium engaged schools where there was not a school-wide career pathway program and students participating in CTE had a considerably different experience than their non-CTE counterparts.

CHAPTER 3: STUDENT TRANSITION TO THE COMMUNITY COLLEGE: PARTICIPATION, COLLEGE READINESS, PERFORMANCE, PERSISTENCE, AND CREDENTIAL ATTAINMENT

This chapter provides an analysis of postsecondary outcomes. Rich data were provided by the Northwest site, while only directory information was available from the Southeast site. For the Northwest site, high school transcripts and surveys were obtained for a small sample of students.

Records from the Northwest community college were analyzed regarding the following questions:

1. How does the college transition and performance of participants in the transition programs compare to that of students in other high school programs? Three groups were compared: participants in the target IT/CIS transition program (a CTE transition program involving dual credit), participants in the Running Start (RS) program, and students who participated in neither of these programs.
2. Are there differences in the postsecondary transition and academic performance of students who participated in secondary programs that were highly engaged in the IT/CIS program compared to those who participated in less engaged programs?
3. Does the level of institutional engagement affect the relationship between IT/CIS transition program participation and college outcomes?

High school survey and transcript data for Northwest site students were analyzed to address the research question:

1. What is the relationship of participation in the secondary IT/CIS transition program with high school achievement and academic preparation, self-reported postsecondary and employment outcomes, and the usefulness of coursework to students' jobs?

Directory information from the Southeast site provided limited information, and also had other limitations described later. Within these constraints the research questions were as follows:

1. At what rate do high school EMT students enroll at the community college after high school, continue in a health major, and earn degrees or certificates?
2. Within high schools offering the EMT program, do EMT students continue in a health major and earn degrees or certificates at rates different from those of non-EMT students from the same high schools?
3. Do students from high schools hosting the EMT program opt for health majors and earn degrees or certificates at rates different from students who attended high schools that do not host the dual credit (DC) EMT program?

Transition Practices in the Northwest and Southeast Sites

The Northwest Site

The IT/CIS curriculum in the Northwest site included a total of 52 high schools in the area affiliated with a large, comprehensive community college that has two campuses serving the county. A second community college and two technical colleges also participated in the program. These high schools utilized formal articulation agreements offering CTE dual credit courses to link the secondary Information Technology (IT) curriculum to the postsecondary

Computer Information Science (CIS) curriculum, creating the IT/CIS pathway. To receive dual credit, students were obligated to complete a required high school-level course in Fundamentals in Information Technology (IT), then they had to complete subsequent college-level CTE courses with a grade of B or better. Students could get five college credit hours per course by taking a college-level course in Data Communications, Introduction to Programming, Operating Systems, PC Hardware Fundamentals, and Structured Query Language. Students who matriculated to an AAS degree program could specialize in various areas such as application programming, database developing, or hardware support. The community college offered students the opportunity to transfer to a university in the area that offered upper division undergraduate CIS programs through its Institute of Technology, allowing them to continue their education toward a BS degree in Computing and Software Systems, based on 2+2+2 degree agreements. In addition, high school students were able to take CISCO I, II, III, and IV courses in networking concepts and design that were articulated with two technical colleges in the region. (Student records were not accessible from these institutions or from the other community college, so the students enrolled there were not included in the study.)

Partnerships between the secondary and postsecondary schools made the IT/CIS curriculum possible, but they were not operating in isolation. As noted in Chapter 2, an intermediary agency designed articulation agreements and promoted relationships among the various educational partners and businesses. The intermediary agency was attributed with being the “cog in the wheel” that made CTE-related articulation agreements work by creating processes wherein the community college could establish standards and expectations for college-level learning that were respected by high school personnel. Accountability mechanisms were not seen as heavy handed; indeed, they were used judiciously and respected for giving direction and oversight of course quality. Healthy interpersonal relationships among faculty and administrators had evolved to promote communication and respect.

Several core practices were in place to support and enhance students’ experiences with the IT/CIS curriculum. There were no eligibility requirements or restrictions on students accessing dual credit by participating in the IT/CIS curriculum. Courses were taught in the home high school by regular high school instructors. In addition to the CTE dual credit program, secondary students had the option of participating in Running Start (RS) dual credit. RS provided students with the opportunity to earn high school and college credit by taking college courses on college campuses. The state’s annual report indicated that slightly over 80%, of the RS courses are academically oriented courses, including courses in math, science, and English. The RS program was enacted by the state in 1990 with state legislation, with the community college offering it to eligible students a year later. According to the college Web site, “Students had to place at the level of English 101 to take most classes, or place at college-level math (pre-calculus or equivalent) to take any Math or math-related courses.” Whereas college tuition was free, financial aid was not available and students were responsible for books, college supplies, and transportation expenses. Tuition was paid by state reimbursement at uniform rates by the K-12 school districts. The RS program at the target community college served over 600 high school students annually, with impressive growth in enrollment over the last few years. In the 2003-04 academic year, 86 high school seniors in RS graduated with both a high school diploma and an associate degree, up from 42 students the previous year.

Other core practices of the IT/CIS program included college placement testing (COMPASS and ASSET) on high school campuses to assess college readiness and identify academic deficiencies. Although these tests were primarily given to high school seniors, at least one district tested juniors. The test scores were used to help juniors select courses for the senior year that would address deficiencies. The IT/CIS program at the target community college also required a 250-hour internship as a form of work-based learning. Another important feature was that women and students of color were strategically recruited to participate in CIS courses through a grant from the National Science Foundation (NSF).

The Southeast Site

The Southeast site offered the Emergency Medical Services Technology program consisting of an Emergency Medical Technology Basic (EMT-Basic) and Paramedic (EMT-Paramedic). This program was initiated and coordinated by EMT faculty and affiliated personnel of the region's comprehensive community college that serves a five-county region with a main campus, two campuses in adjacent counties, and an outreach center serving two remote counties. Students in these programs are awarded certifications, and they can extend their course of study to the Associate of Science (AS) degree by taking 20 general education course credits and coursework in supervision. A curriculum of particular interest to this study was the EMT-Basic Dual Enrollment program that began in 2000, offering the students of one nearby high school the opportunity to engage in an 11-hour EMT-Basic curriculum offered via dual enrollment courses offered on the high school campus. The high school students took their courses over an entire academic year, with classroom instruction in the first semester and WBL experiences the following semester. Since its initial offering and development in the one high school, the program was replicated in three additional high schools in the county. Students in these schools came to the community college branch campus for classroom instruction.

The EMT curriculum was sequenced in a career ladder. Students were required to complete the EMT-Basic curriculum, and at the completion of this program they were trained to function as entry-level EMTs, received a certificate of completion, and sat for the National Registry EMT certification exam if they earned a C or better in their courses. If students passed the exam, they were eligible to be employed as entry-level EMTs once they turned 18. If students chose to pursue additional coursework in the career pathway, they continued to complete EMT-Paramedic courses. To receive the AS degree, students had to complete both the EMT-Basic and EMT-Paramedic curricula, plus two classes to prepare them for management positions in EMS and fire agencies, and 20 credits of general education classes.

High school students in the Southeast site were provided a variety of college options such as dual enrollment, early admission, AP, and International Baccalaureate (IB), and the statute allowed dual enrollment for eligible high school students that exceeded the state's guidelines for dual enrollment. The EMT program had even higher and more specific criteria to gain admittance. The students had to be seniors with a GPA of 3.5, they had to complete an application to the college, they had to possess CPR certification granted by the American Heart Association or American Red Cross, and they had to earn college-level placement reading test scores or an ACT-E score of at least 18. After the program began, the EMT administrators changed the criteria by adding the minimum test scores on verbal and reading because of the change in certification exams from the state certification exam to the National Registry that required increased reading and critical thinking skills.

Other core practices associated with the EMT curriculum were contextual (hands-on) teaching and learning strategies to engage and motivate students to learn the highly technical material, along with the alignment of the occupational skills standards of the profession and the state. A deliberate focus on career exploration was tied to the career pathway curriculum to enhance students' knowledge of the medical profession and help them determine their level of interest in a career in the health field. WBL was a requirement in that students had to complete a 30-hour clinical experience (for EMT-Basic), plus 72 hours of field internships including riding in ambulances to observe and perform pre-hospital care under the direction of EMTs and paramedics. A parent orientation was offered to provide information about the technical skills students would be learning while enrolled in the program, partly to relieve worries about the stress of the training. The community college's University Center offered transfer agreements with six regional colleges and universities, including a bachelor's degree in nursing in the state university system or transfer to a private university to earn a bachelor's degree in health services, though these agreements were not utilized by EMT students at the time of our study.

Northwest Site: Method

Participant Selection

The community college in the Northwest site provided demographic and transcript information for students who were at least 18 years of age ($N = 6505$) who were enrolled between fall 2000 and spring 2004 in one of 25 feeder high schools. In order to solicit high school transcripts and administer a follow-up survey, a stratified random sample was drawn from among those students who had attended seven targeted high schools with articulation agreements in the IT/CIS area. These seven were the five schools studied in the secondary component of the study, augmented by two others to provide another unengaged and low engaged school, and a better balance of racial-ethnic diversity and proportion of students in the school qualifying for free or reduced lunch within categories of engagement in the IT/CIS program. Table 19 provides information about these schools. The secondary study schools are numbers 1, 6, 11, 16, and 17, and the two others were 14 and 19.

Several attempts were made to contact all students in the sample by letter, telephone, and e-mail. Students were offered $20 in exchange for permission to access their high school transcripts. A second sample of students was approached due to a low response rate. In all, 85 students agreed to release their records. In spring 2005, 110 surveys were mailed to these 85 and to others whom UIUC researchers had been unable to reach about high school transcripts. Participants who did not return the instrument by mail were surveyed over the phone. The response rate for the follow-up survey of Northwest site participants, adjusted for adequate contact information, was 74%.

Sample Characteristics

Most analyses are based on 6,505 students who attended the target community college after high school, taking at least one course that was not a high school completion course, a GED course, or a CTE dual credit or Running Start (RS) course. Because the community college did not require high school graduation or transcripts, it was necessary to find another way to establish whether community college enrollment took place during or after high school. The first post-high school quarter was chosen by eliminating any term in which the student took only

Table 19.
Proportion with Free/Reduced Lunch and Level of Engagement in CIS DC and all CTE DC for Sample High Schools

School	Enrollment	Sample Size	Free/Reduced Lunch	Global CTE DC Engagement	IT/CIS DC Engagement
1[a]	1871	521	0.266	Medium	High
2	730	18	0.201	Low	None
3	1478	352	0.409	Low	None
4	1379	300	0.183	Medium	None
5	680	156	0.287	Low	None
6[a]	1409	230	0.141	High	High
7	777	102	0.222	Medium	None
8	1936	253	0.471	Medium	None
9	1159	285	0.380	Low	None
10	1743	73	0.066	Low	Low
11[a]	1564	838	0.144	High	High
12	1521	436	0.193	Low	None
13	1745	126	0.639	Medium	None
14	524	128	0.200	Medium	Low
15	1527	52	0.213	Low	Low
16[a]	1559	709	0.166	High	High
17[a]	1765	514	0.300	Medium	None
18	1705	107	0.271	Low	None
19	675	242	0.095	Medium	None
20	1702	359	0.184	Low	High
21	237	49	0.354	Low	Low
22	965	245	0.396	Low	None
23	1250	142	0.221[b]	Medium	Low
24	1726	175	0.292	Medium	None
25	1447	93	0.313	Medium	None

Note. Data obtained from the State Office of Superintendent of Public Instruction Web site (*http://reportcard.ospi.k12.[state].us/*) on May 8, 2005, from 2003-04 school report cards.
[a]Schools also studied by AED in the secondary component.
[b]No data were available on the school report card, so the most recent (2002-03) data gathered from the NCES website (*http://nces.ed.gov/globallocator/*) on May 8, 2005, were used instead.

non-credit extension courses or high school completion or GED courses, as well as terms in which the student took a CTE DC or RS course. If the student reported the year of high school graduation, the first post-high school quarter was judged to be the first such term after that date. Four students who participated in both CIS DC and RS were omitted from the sample.

Variables: Age, Gender, Racial/Ethnic Background, and Socioeconomic Status (SES). These background variables were controlled to the extent possible. The CTE transition program became solidly institutionalized and quite active in 2000, while the RS program was begun in 1990. Since many PSE outcomes are affected by the amount of time the student has to show evidence of the outcome, comparison of students in the newer CIS DC program with either RS students or non-participants would be biased without a control for cohort. Because date of high school graduation was not known for many students, age was used instead. Students' "academic age" was defined based on the September through August in which they were born. These ages were categorized, ranging from 18-19 through 26 and older. For students who reported date of high school graduation, the correlation between this measure and graduation date was .895, supporting its accuracy for this purpose. The target community college provided age, gender, and racial/ethnic background, but not socioeconomic status (SES), so SES was a school level variable indicated by percentage of free/reduced-price lunch-eligible students.

Remedial Level in Mathematics and Communication. Because no other index of high school academic performance was available, the levels of remedial coursework in mathematics and communications from very low through college level were used as covariates in analyses of college performance, persistence, and credential attainment. These variables are defined below.

Degree Intent. Students' intent to earn a transfer associate's degree, to earn a vocational degree or certificate, to complete a pre-major, or degree intent/other was available based on a voluntary question on the target community college registration forms. It was used as a covariate in some analyses.

The independent variables are engagement of the high school in the CIS DC transition pathway program and CTE participation on the part of the student.

Participation in the CTE Transition Program. Participation in the CTE transition pathway program was defined as successful completion with a grade of A or B of one or more articulated courses in CIS or Digital Design.

Engagement in the CTE Transition Program. High school engagement in the program was defined by the number of IT/CIS articulation agreements the high school had with the target community college (categorized as "Not at all engaged = 0 articulation agreements", "Low = 1-2", "High = 4-6") and also by a global rating of high school engagement by the director of the intermediary organization. To rate the level of engagement of secondary schools on a 4-point scale with 1 = None, 2 = Low, 3 = Medium, and 4 = High, she considered recent dual credit enrollment, use of products and services (e.g., flyers, bookmarks, calendars, videos and CDs, postcards, and posters), and participation in governing board meetings for the present year.

The dependent variables included college participation, college readiness, academic performance, persistence, and credential attainment.

College Participation. Measures of participation were enrollment at the community college and continuation in the IT/CIS pathway after high school. Because the sample consisted of students who enrolled at the target community college, enrollment rate can only be compared for students who began their PSE study while in high school through IT/CIS DC or RS. Students were considered to have continued in the IT/CIS pathway if they took at least one CIS, Digital Design, or Computer Network Engineering course after high school. (The Computer Network Engineering course is offered at the postsecondary level only.)

College Readiness. Placement test scores were not available, so readiness was assessed by whether or not students enrolled in remedial courses and by the level of the remedial courses in which they enrolled. Students were considered in need of remediation if they took a remedial course in mathematics or communication (reading or writing).

Remedial level was defined using college course descriptions and associated placement scores. In math, the lowest level of remediation (Level 1) was assigned to Adult Basic Education (ABE) courses covering basic arithmetic. Levels 2-4 were assigned to courses that covered further arithmetic (e.g., fractions and decimals) to pre-algebra (e.g., signed numbers, graphing, and solving linear equations). Levels 5 and 6 were assigned to introductory algebra courses, including two in business. Level 7 designated enrollment in an intermediate algebra course. Students taking none of these remedial courses were assigned Level 8.

In communication, Level 1 also was assigned to ABE courses (e.g., phonics and alphabet recognition, reading for comprehension, and using correct punctuation and grammar). Level 2 referred to courses on phonics and word analysis, sentence structure, and paragraph development. Level 3 courses involved finding main ideas, drawing inferences from reading, and writing. Level 4 courses focused on reading comprehension, study skills, and writing. Students taking none of these courses were assigned Level 5.

Academic Performance. Measures of PSE academic performance are GPAs in all college level courses (100 level and above), college level courses in math and English, and post-high school CIS courses. Following the community college's practice, these exclude courses for remediation; high school completion; functional language skills, such as English as a Second Language (ESL); and non-credit continuing education. However, they do include courses taken for dual credit while in high school. IT/CIS dual credit courses receive college credit only if the student earns an A or B. RS classes, however, are part of the college record regardless of the grade earned.

Persistence. Measures are the total terms enrolled at the college after high school and total college level credits earned.

Credential Attainment. This was measured by whether or not a student earned a degree or certificate. The number of terms of enrollment post-high school before the student attained a transfer associate degree was also examined ($N = 1127$).

High School Academic Preparation. High school transcripts were analyzed to determine student progress in math, English, foreign language, and science. In math, each course was assigned a value from 2 (non-academic) to 8 (calculus) according to the rubric proposed by Burkam and Lee (2003) (see Appendix D). The highest value course in which credit was earned by a student corresponded to that student's progress in the pipeline. The same process was used for the science pipeline. Progress in the foreign language pipeline was determined by the number of Carnegie units earned in the highest level of a language taken by the student (Burkam & Lee, 2003). However, a student may score high in the pipeline and yet only take a single semester of a foreign language, e.g., a single semester in German IV. In English, following Burkam (2003), courses were coded as honors or advanced English, below-grade English, regular English (grade level), or other regular English (not labeled as to grade level). Then each student was assigned a pipeline value according to the proportion of each type of course taken during their high school career. For example, a student who took one honors course and three regular courses of equal credit would be assigned a "5" in the pipeline.

Students were identified as college prep if they met the criteria for an academic specialist in the National Center for Education Statistics *Procedures Guide for Transcript Studies* (Alt & Bradby, 1999): at least 4 credits in English; at least 3 credits in mathematics at the Algebra 1 level or higher; at least 2 credits in biology, chemistry, or physics; at least 2 credits in social studies with at least 1 credit in U.S. or world history; and at least 2 credits in a single foreign language.

The fact that students were clustered within 25 high schools suggests a multi-level analysis. Analyses of continuous dependent variables indicated a very low proportion of variance at the school level. Thus, the need for treatment of these data as clustered was modest, and the value of trying to model the school-level variance would also be small. For example, the intraclass correlation coefficient for the random effects ANOVA for remedial mathematics level was .013, and for remedial level in communication it was .029. Thus, single level ordinary least squares and logistic regression were used instead.

Northwest Site: Results and Discussion

Table 19 (see page 35) provides information about enrollment and sample sizes for the 25 high schools that students reported having attended. It also indicates the proportion of students in each school who qualify for free and reduced lunch, and provides two measures of the degree of involvement of the school in the CTE transition program. The first of these, "Global CTE Dual Credit (DC) Engagement" is the rating described earlier. The second, IT/CIS DC Engagement, is a count of the number of CIS DC courses offered by the high school according to a check of the coordinating organization's Web site during the fall term of 2004. This more narrowly tailored index of engagement is the primary measure of engagement used in these analyses.

Demographic characteristics of students in the sample are described below. Table 20 indicates that students who had taken any PSE CIS (the CIS total group) are more likely to be male (57.5%) than are those who took no CIS (38.8%). In addition, both IT/CIS groups—i.e., the dual credit (DC) and Running Start (RS) groups—were compared to each other and to all of the non-participants. This latter group contains the non-participants who took at least one PSE CIS course and also those who took no PSE CIS courses. While the DC and RS groups did not differ in gender makeup, both the DC and RS groups exceeded the non-participants in percentage who were male. These differences appear to be largely driven by the large difference in the rates at which males and females enroll in CIS courses. Finally, Table 20 indicates that CIS DC and RS students are both younger than non-participants.

Table 21 shows that students who took some PSE CIS coursework differ significantly in racial/ethnic background from those who did not, with more Asian Americans taking CIS. Statistical comparisons of the DC and RS groups to each other or to non-participants were not attempted because of low expected frequencies. However, the CIS DC group appears more heavily of white background and less representative of Asian/Pacific Islander, African American, and Hispanic students than the RS and non-participant groups. The seeming concentration of white students in the CIS DC program raises concerns about access. It seems likely that schools with higher concentrations of minority students are less engaged in this program, perhaps due to fewer resources. Indeed, the correlation of percentage of white students in these 25 schools with the number of CIS DC courses offered was .432 ($p < .05$), meaning that schools with higher minority enrollment are less engaged in the program, on average.

Table 20.
Gender and Age, Enrollment in CIS Courses, and Participation in CIS DC or RS

	Took at least one CIS course				Non CIS	Total
	DC	RS	Non-participants	CIS total		
Percentage Male	76.6%	62.3%	56.3%	57.5%	38.8%	42.3%
Mean Age	20.81	21.34	22.88	22.70	22.52	22.56
N	47	77	1084	1208	5297	6505

Note. For gender, between those taking CIS and those not, $x^2(1) = 139.7$, $p < 0.001$; between CIS DC and non-participant (CIS and non-CIS non-participants combined) groups, $x^2(1) = 23.19$, $p < 0.001$; and between CIS RS and combined non-participant groups, $x^2(1) = 13.18$, $p < .001$.
For age, between those taking CIS and those not, $t(6503) = 3.02$, $p < 0.005$; between CIS DC and combined non-participant groups, heterogeneous variances, $t(58.0) = -13.50$, $p < 0.001$; and between CIS RS and combined non-participant groups, heterogeneous variances, $t(108.4) = -12.27$, $p < 0.001$.

Table 21.
Ethnicity, Enrollment in CIS Courses, and Participation in CIS DC or RS

Ethnicity		Took at least one CIS course				Non CIS	Total
		DC	RS	Non-participants	CIS total		
White	Count	42	51	714	807	3602	4409
	%	89.4%	66.2%	65.9%	66.8%	68.0%	67.8%
American Indian	Count	1	0	15	16	98	114
	%	2.1%	.0%	1.4%	1.3%	1.9%	1.8%
Asian/Pacific Islander	Count	3	13	178	194	606	800
	%	6.4%	16.9%	16.4%	16.1%	11.4%	12.3%
African American	Count	0	3	79	82	439	521
	%	.0%	3.9%	7.3%	6.8%	8.3%	8.0%
Hispanic	Count	1	6	61	68	350	418
	%	2.1%	7.8%	5.6%	5.6%	6.6%	6.4%
Blank and Other	Count	0	4	37	41	202	243
	%	.0%	5.2%	3.4%	3.4%	3.8%	3.7%
Total	Count	47	77	1084	1208	5297	6505
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note. Between those taking CIS and those not, $x^2(5) = 23.5$, $p < 0.005$.
Follow-up tests comparing CIS and non-CIS students indicated that the distributions were the same except for a higher concentration of Asian/Pacific Island students in the CIS group.

Table 22 indicates that the participation groups differ significantly in their self-reported degree objectives, with those who took CIS courses more likely to seek vocational degrees or certificates than those who did not. Follow-up tests were not performed because of many cells with low frequencies, yet it appears that RS students had the highest rate of seeking a transfer associate's degree, at 83.1%.

Table 22.
Self-reported Degree Intent, Enrollment in CIS Courses, and Participation in CIS DC or RS

Degree Intent		Took at least one CIS course				Non CIS	Total
		DC	RS	Non-participants	CIS total		
Transfer Associate Degree	Count	31	64	842	937	4179	5116
	%	66.0%	83.1%	77.7%	77.6%	78.9%	78.6%
Pre-majors	Count	0	0	6	6	126	132
	%	0.0%	0.0%	0.6%	0.5%	2.4%	2.0%
Vocational Degree or Certificate	Count	8	8	163	179	355	534
	%	17.0%	10.4%	15.0%	14.8%	6.7%	8.2%
Nondegree or Blank	Count	8	5	73	86	637	723
	%	17.0%	6.5%	6.7%	7.1%	12.0%	11.1%
Total	Count	47	77	1084	1208	5297	6505
	%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

Note. Between those taking CIS and those not, $x^2(3) = 117.6$, $p < 0.005$.

Research questions 1-3 concerning students' community college records call for an examination of the effects of CIS DC participation and of level of the high school's engagement in the DC program on college participation, readiness, performance, persistence, and credential attainment, as well as an evaluation of whether or not these two variables interact in their effect on college readiness. Because students could also participate in the RS program, the effect of RS participation on college outcomes was also tested.

Participation in Postsecondary Education

Participation was examined via enrollment at the target community college and continuation in CIS courses after high school. Of the 142 students enrolling in CIS DC, 47, or 33.1%, subsequently enrolled at the community college. Among RS participants, the rate was identical: 81 of 245 (33.1%). There is no way to compare enrollment rates of these groups with the non-participants, all of whom had enrolled at the community college. Of 47 CIS DC students who continued at the college, 26 (55%) continued in the same or a related field by taking at least one course in CIS, Digital Design, or Computer Network Engineering after high school.

College Readiness

Table 23 indicates that the three groups of students differ in their rates of taking some remedial courses, remedial math courses, and remedial communication courses. Follow-up tests indicated that CIS DC students differed significantly from non-participants in the percentage who took remedial courses in communication. At the same time, fewer RS than non-participating students took remedial courses in mathematics, communications, or other subjects, but no significant differences were found between the CIS DC and RS groups in remedial enrollment. The percentage of students taking remediation was about what the researchers expected. Non-participants needed some remediation at the rate of 70%, with 64% needing remediation in mathematics. Recent analysis by Adelman (2005) of members the high school class of 1992 who entered community colleges without delay after graduating from high school revealed that about 60% were required to take remedial courses. The remedial need of the RS students was lower, as expected, since they had to place at the college level in the relevant area to take a community college course while in high school. Concerning the level of remedial courses these students took, Table 24 indicates that the CIS DC group started at a higher level than non-participants in mathematics and communication coursework, as did the RS group. The CIS DC and RS groups did not differ, however.

Table 23.
Frequencies and Percentages of CIS DC, RS, and Others Taking at Least One Remedial Course (Math and Communication)

		Taking at least one remedial course		Taking at least one remedial math course		Taking at least one remedial communication course	
Participation	N	Count	%	Count	%	Count	%
CIS Dual Credit	47	26	55.3	23	48.9	9	19.1
Running Start	81	32	39.5	28	34.6	6	7.4
Non-participant	6377	4487	70.4	4105	64.4	2352	36.9
Total	6505	4545	69.9	4156	63.9	2367	36.4

Note. For general remedial need, Pearson's chi-square was 40.934 (2 *df*; $p < .001$). Follow-up tests at the $p < .05/3$ significance level were conducted for each pair, yielding one significant difference between RS and non-participants, Pearson's chi-square = 36.240, (1 df, $p < .001$).
For math remedial need, Pearson's chi-square was 35.384 (2 *df*; $p < .001$). Follow-up tests at the $p < .05/3$ significance level were conducted for each pair, yielding one significant difference between RS and non-participants, Pearson's chi-square = 30.836 1 df, $p < .001$).
For communication remedial need, Pearson's chi-square was 36.099 (2 *df*; $p < .001$). Follow-up tests at the $p < .05/3$ significance level were conducted for each pair, yielding two significant differences, between both DC and RS compared to non-participants, Pearson's chi-square = 6.132 (1 df, $p < .017$) for DC and Pearson's chi-square = 29.977 (1 df, $p < .001$) for RS.

Table 24.
Level of Remediation Taken by CIS DC, RS, and Other Students

		Mathematics		Communication	
Groups	N	Mean	*SD*	Mean	*SD*
CIS DC	47	7.02	1.34	4.79	0.46
RS	81	7.33	1.20	4.93	0.26
Non-participant	6377	6.25	1.87	4.51	0.74
Total	6505	6.27	1.86	4.52	0.73

Note. For mathematics: $F(2,6502) = 17.366$, $p < .001$. In post hoc Tukey test, only the differences of two pairs are significant: both RS and DC, versus non-participants. DC and RS did not differ.
For communication: $F(2,6502) = 16.03$, $p < .001$. In post hoc Tukey test, only the differences of two pairs are significant: both RS and DC, versus non-participants. DC and RS did not differ.

Tables 25 through 29 extend these results by applying controls for students' age, gender, race/ethnicity (i.e., student characteristics), and the proportion of students in their schools eligible for free or reduced price lunch (i.e., high school SES). The effects of participation in CIS DC or RS courses and the level of the high school's engagement in the CIS DC program were all tested with these controls, as was the interaction of CIS DC participation and engagement. In no case was the interaction significant (see footnotes to tables). Tables 25 through 27 indicate that with other factors controlled, students from high schools that were more engaged in the CIS DC program took remedial courses at a higher rate (overall, math, and communication) than did students from schools that were less engaged. There was a significant tendency for CIS DC students to have taken remediation at a lower rate than non-participants for communication, but not for math or in general. Likewise, a tendency for RS students to have taken remediation at a lower rate than CIS DC students was significant for communication but not for mathematics or overall. RS students were less likely to need remediation in math, communication, or in general than non-participants (see footnotes to tables). Control variables were related to these outcomes in expected ways—i.e., males were less likely to take remediation in math than were females, and females were less likely to need remediation in communication. African American students were more likely than white students to take remediation overall and in both subject areas, Hispanic and Asian/Pacific Islander students were more likely than white students to take remedial communication courses, and students from schools with higher incidence of free/reduced lunch eligibility were more likely to take remedial courses in general and in both subject areas.

Table 25.
*Logistic Regression of the Need for Some Remediation on Student Characteristics, High School SES, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variable	*B*	*SE B*	Exp(*B*)	
Age	.016	.017	1.016	
Male	-.096	.055	.083	
African American	.698	.121	2.010	***
American Indian	.090	.210	1.095	
Asian/Pacific Islander	.050	.087	1.052	
Hispanic	.087	.113	1.091	
Other, Unknown	-.232	.139	.793	
Prop. Free/Reduced Price Lunch	1.227	.286	3.411	***
Non-participant	.526	.298	1.692	
RS Participation	-.666	.373	.514	
High School Engagement	.048	.013	1.049	***

Note. For the model, x^2 = 107.439***, *df* = 11.
For the test of an interaction between CIS DC participation and high school engagement: x^2 = .173, *df* = 1.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and all other groups are compared to it one by one.
For the comparison of RS and non-participant groups, *B* = -1.192***.
**p* < .05, ***p* < .01, ****p* < .001

Table 26.
*Logistic Regression of the Need for Math Remediation on Student Characteristics, High School SES, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variable	*B*	*SE B*	Exp(*B*)	
Age	.026	.016	1.027	
Male	-.148	.053	.863	**
African American	.556	.109	1.743	***
American Indian	.130	.202	1.139	
Asian/Pacific Islander	-.107	.082	.899	
Hispanic	.026	.108	1.027	
Other, Unknown	-.230	.135	.794	
Prop. Free/Reduced Price Lunch	.761	.269	2.141	**
Non-participant	.516	.296	1.675	
RS Participation	-.594	.375	.552	
High School Engagement	.043	.012	1.044	**

Note. For the model, $x^2 = 92.821$***, *df* = 11.
For the test of an interaction between CIS DC participation and high school engagement: $x^2 = 2.087$, *df* = 1.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and all other groups are compared to it one by one.
For the comparison of RS and non-participant groups, *B* = -1.109 ***.
$*p < .05$, $**p < .01$, $***p < .001$

Table 27.
*Logistic Regression of the Need for Communication Remediation on Student Characteristics, High School SES, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variable	*B*	*SE B*	Exp(*B*)	
Age	-.004	.016	.996	
Male	.117	.053	1.124	*
African American	.787	.098	2.198	***
American Indian	.337	.195	1.401	
Asian/Pacific Islander	.553	.081	1.739	***
Hispanic	.470	.105	1.601	***
Other, Unknown	-.065	.144	.937	
Prop. Free/Reduced Price Lunch	1.588	.266	4.894	***
Non-participant	.774	.375	2.168	*
RS Participation	-1.228	.566	.293	*
High School Engagement	.035	.013	1.035	**

Note. For the model, $x^2 = 226.916$***, *df* = 11.
For the test of an interaction between CIS DC participation and high school engagement: $x^2 = 1.411$, *df* = 1.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and all other groups are compared to it one by one.
For the comparison of RS and non-participant groups, *B* = -2.002***.
$*p < .05$, $**p < .01$, $***p < .001$

Tables 28 and 29 examine the level of remedial courses needed in communication and mathematics. In neither case was the interaction of engagement of the high school with student's participation in CIS DC significant. The level of coursework at which students began their study of math was related to CIS DC participation and to the level of the school's engagement in the program, with CIS DC students starting at a higher level than non-participants, and with students from more engaged high schools starting at lower levels than students from less engaged high schools. RS students also started at a higher level than non-participants, and CIS DC and RS students did not differ in level of remediation. Again controls behaved as expected, with males starting at higher levels of math than females; African American, American Indian, and Hispanic students starting at lower levels of math than white students; and students from schools with higher incidence of free or reduced lunch eligibility also tending to start at lower levels of math than other students. Concerning communication courses, CIS DC students did not differ in starting level from non-participants. Engagement of the high school also had no effect. RS students averaged a higher level of starting coursework than non-participants, while the CIS DC and RS groups did not differ. African American, Asian/Pacific Islander, and Hispanic students all tended to start at lower levels than white students, and students from schools with higher incidence of free or reduced lunch eligibility tended to start with lower level courses than others.

Table 28.
*Linear Regression of Mathematics Remedial Level on Student Characteristics, High School SES, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variable	*B*	*SE B*	*x*	*t*	
(Constant)	7.224	.282		25.637	***
Age	-.021	.014	-.019	-1.502	
Male	.216	.046	.057	4.637	***
African American	-.760	.088	-.111	-8.591	***
American Indian	-.470	.175	-.033	-2.690	**
Asian/Pacific Islander	.118	.073	.021	1.622	
Hispanic	-.198	.095	-.026	-2.082	*
Other, Unknown	.102	.122	.010	.837	
Prop. Free/Reduced Price Lunch	-1.033	.234	-.063	-4.422	***
Non-participant	-.574	.272	-.043	-2.114	*
RS Participation	.364	.338	.022	1.075	
High School Engagement	-.033	.011	-.044	-3.072	**

Note. Adjusted R^2 = 0.027, and the regression function is significant: F (11, 6493) = 16.322***.
For the test of an interaction between CIS DC participation and high school engagement: ΔR^2 = .000: F (1, 6492) = .079.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and all other groups are compared to it one by one.
For the comparison of RS and non-participant groups, B = .938: t (6493) = 4.527***.
*p < .05, **p < .01, ***p < .001

Table 29.
*Linear Regression of Communication Remedial Level on Student Characteristics, High School SES, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variable	*B*	*SE B*	*x*	*t*	
(Constant)	4.963	.110		45.229	***
Age	-.006	.005	-.014	-1.151	
Male	-.022	.018	-.015	-1.193	
African American	-.333	.034	-.123	-9.663	***
American Indian	-.114	.068	-.020	-1.680	
Asian/Pacific Islander	-.259	.028	-.116	-9.119	***
Hispanic	-.197	.037	-.066	-5.332	***
Other, Unknown	-.002	.047	.000	-.037	
Prop. Free/Reduced Price Lunch	-.540	.091	-.084	-5.943	***
Non-participant	-.194	.106	-.037	-1.833	
RS Participation	.207	.132	.031	1.571	
High School Engagement	-.005	.004	-.018	-1.294	

Note. Adjusted $R^2 = 0.044$, and the regression function is significant: F (11, 6493) = 27.338***.
For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .000$: F (1, 6492) = .765.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and all other groups are compared to it one by one.
For the comparison of RS and non-participant groups, $B = .401$: t (6493) = 4.969***.
*$p < .05$, **$p < .01$, ***$p < .001$

In sum, with other factors controlled, the CIS DC students were more likely to be college ready than the non-participants in communication but not in mathematics or overall. But the CIS DC students also started at a higher level, on average, in mathematics but not communication than the non-participant group. Thus, there is some evidence that CIS DC participation may have been associated with better college preparation than was non-participation. The inability to control for academic achievement level (due to a lack of information about high school performance) lessens the certainty with which we can conclude that dual credit participation had a positive effect. Possibly it is the better students in these high schools who chose to participate, and who earned a grade of A or B and thus had their participation reflected in the community college record.

Level of high school engagement showed a surprising effect. Students from higher engaged high schools were more likely to need remediation in both mathematics and communication. They also started at a lower level of mathematics remedial course, on average. This was the opposite of what we expected. It seemed possible that higher engaged high schools tended to send their weaker students to the target community college, perhaps emphasizing four-year college over community college enrollment. To attempt to control this, additional models were tried for all four dependent variables, adding self-reported degree intent to the variables already used. In no case did the addition of information about the academic orientation of the student reduce the effect of high school engagement, much less its significance. In all cases the regression coefficient for engagement remained the same or became slightly larger. Thus, the mechanism by which school engagement may affect students' remedial need and level are simply not clear.

Finally, there was no suggestion in these data that the effects of CIS DC participation on remediation, if any, might vary with high school engagement in the DC program. This hypothesis received no support.

Postsecondary Performance

Measures of performance included GPAs in all college-level courses, in college-level English, in college-level mathematics, and in CIS courses taken after high school. Covariates are those used before, and beginning remedial levels in mathematics and communication. The latter variables provide control for the academic preparation level at the college. Students' stated degree intent was also a covariate, as aspirations might differ with DC participation and could affect outcomes. Table 30 summarizes the results.

GPAs were not well predicted by the covariates and the independent variables, with 6-9% of the variance accounted for. The overall GPAs of CIS DC participants averaged about 0.8 higher than those of non-participants, but there were no group differences for mathematics, English, or post-high school CIS GPAs. Since CIS dual credit courses taken in high school were recorded on community college transcripts only if students earned an A or B, overall GPA is inflated by excluding any lower grades in DC courses. RS students, all of whose grades are recorded, had GPAs about .4 higher than the GPAs of non-participants ($p < .001$). The difference between CIS DC and RS participants was not significant. Since there was no difference between college level English, mathematics, or post high school CIS GPAs for CIS DC participants and non-participants, it seems likely that the effect is spurious for GPA in all college-level courses. Thus we conclude that in terms of GPAs, the CIS DC students were doing as well as the more select group of RS students, who, unlike the CTE DC participants, had to pass college placement tests before being permitted to enroll in dual credit courses at the community college.

It is also noteworthy that there were no differences in the groups' GPAs in post-high school CIS courses. To the extent that the CIS DC students took more advanced courses at the community college than they had taken for dual credit during high school (55% went on to take a CIS course at the target community college), their preparation was adequate. Since dual credit courses are offered by high school faculty in the high school, this finding suggests that the articulation process is working reasonably well in delivering college-level coursework in the high schools.

Engagement level of the high school in the CIS dual credit program, measured as number of CIS articulated courses offered, was not significant for any of the GPAs. The interaction between CIS DC participation and high school engagement level was also non-significant for all four GPAs.

Among covariates, age generally had a positive effect on GPA, while males earned lower grades by one-quarter to one-third of a grade point in all areas and overall than did females. African-American students earned lower grades than did white students in all areas by about four-tenths of a grade point, while Hispanic students had lower grades than white students only overall and in English, by about two-tenths of a grade point. Better prepared students, in terms of remedial levels, tended to earn higher GPAs than did others. Each additional level of higher

Table 30.

*Linear Regression of Total, English, and Mathematics College Level GPAs and Post-High School CIS GPA on Student Characteristics, High School SES, Math and Communication Remedial Levels, Degree Intent, CIS DC and RS Participation, and High School Engagement (*N *= 6505; for Post-high School CIS,* N *= 1101)*

Variables	1. Total College-Level GPA		2. College-Level English GPA		3. College-Level Mathematics GPA		4. Post-High School CIS GPA	
	B		*B*		*B*		*B*	
(Constant)	1.913	***	2.025	***	1.124	***	1.995	
Age	0.055	***	-0.006		0.042	**	0.036	*
Male	-0.250	***	-0.275	***	-0.340	***	-0.204	***
African American	-0.394	***	-0.410	***	-0.458	***	-0.412	***
American Indian	-0.364	***	-0.433	***	-0.569	**	-0.083	
Asian/Pacific Islander	-0.019		-0.071		-0.125		0.027	
Hispanic	-0.179	**	-0.194	**	-0.168		-0.064	
Other, Unknown	0.056		-0.059		-0.064		0.033	
Prop. Free/Reduced Price Lunch	-0.189		-0.081		0.073		-0.047	
Math Rem. Level	0.069	***	0.067	***	0.033		0.052	***
Comm. Rem. Level	0.196	***	0.116	***	0.274	***	0.156	***
Intent-Premajor	0.058		0.173		0.569	***	0.069	
Intent-Vocational Deg./Cert.	-0.033		0.051		-0.033		-0.106	
Intent-Other/Nondeg./Blank	-0.494	***	-0.160	*	0.111		0.062	
Non-participant	-0.812	***	-0.125		-0.196		0.019	
RS participant	-0.372		-0.045		-0.251		-0.087	
High School Engagement	-0.004		0.006		0.004		-0.001	

Note. For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one. For degree intent, transfer associate is used as an anchor and all other intent categories are compared to it one by one. For participant groups, CIS DC is used as an anchor, and RS and non-participant groups are compared to it one by one.
For total college level GPA , adjusted $R^2 = .092$, and the regression function is significant: F (16, 6488) = 64.18***. For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .000$; F not significant. For the comparison of RS and non-participant groups, $B = .441$: t (6488) = 3.53***.
For college level English GPA, adjusted $R^2 = .058$, and the regression function is significant: F (16, 4161) = 17.20***. For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .000$; F not significant. For the comparison of RS and non-participant groups, $B = .080$: t (4161) = .67.
For the college level mathematics variable, adjusted $R^2 = .076$, and the regression function is significant: F (16, 2308) = 13.03***. For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .001$; F not significant. For the comparison of RS and non-participant groups, $B = -.055$: t (2308) = -.36.
For post-high school CIS GPA, adjusted $R^2 = .066$, and the regression function is significant: F (16, 1084) = 5.875***. For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .000$; F not significant. For the comparison of RS and non-participant groups, $B = -.106$: t (1084) = -.597.
*$p < .05$, **$p < .01$, ***$p < .001$

preparation in communication, between the lowest remedial course and the top level (college ready) was associated with one- to three-tenths higher grade points for the four GPAs. Better preparation in mathematics by one level was associated with less than one-tenth of a grade point better GPAs overall, in English, and in post-high school CIS, but not in mathematics.

Postsecondary Persistence

Persistence measures are total terms enrolled at the college after high school and total college level credits earned. Table 31 summarizes linear regression models for both dependent variables using the same independent variables and covariates as before. For both, there was no effect for high school engagement, and there was no interaction between high school engagement in the dual credit CIS program and CIS DC participation. Terms enrolled after high school did not differ for the three groups, but there were group differences in college level credits earned. CIS DC students earned more credits than did non-participants, the mean difference being 22.3 credit hours. RS participants also earned more credits than did non-participants, by 36.4 credits on average. Participants in RS averaged 14.1 more credits than those in CIS DC ($p < .05$).

Older students enrolled longer and earned more credits, which was expected because they had had more time since high school in which to enroll and amass credit at the target community college. Male students averaged .2 terms fewer than female students, and amassed an average of 5 fewer credits. There were no racial/ethnic differences in terms enrolled, but African American, American Indian, and Hispanic students earned fewer credits than white students.

Those students with higher remedial levels in both math and communication (less remedial need) enrolled in fewer terms than students with a lower remedial level, but earned more college-level credit. This suggests that students are not necessarily being hindered in continuing their studies by their need for remediation, at least in the short term, but are continuing their enrollment even though the courses do not add college-level credits toward any certificate or degree, thus lowering their total credits earned. Finally, students with the intention of earning vocational credentials, or with no discernible intentions at all, tended to enroll in .5 to one full term more than those intending to earn transfer associate's degrees, and those without intent earned an average of 23 fewer credits than did students seeking a transfer degree.

In sum, persistence was not well predicted by the demographic variables, levels of preparation, degree intent, and DC participation status, with at most about 11% of the variance accounted for. However, college-level credits earned was assisted by both RS and CIS DC participation. Since these groups and the non-participants were all quite close in the number of terms enrolled, we hypothesize that the difference in credits earned may be largely the result of credits earned while in high school by the two groups who earned dual credit. As with GPAs, there was no effect of engagement, and there was no interaction effect.

Table 31.

*Linear Regression of Post High School Terms Enrolled and Total College Level Credits Earned on Student Characteristics, High School SES, Math and Communication Remedial Levels, Degree Intent, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variables	1. Terms after High School		2. College Level Credits Earned	
	B		*B*	
(Constant)	4.550	***	28.980	***
Age	.569	***	4.471	***
Male	-.202	*	-5.403	***
African American	-.347		-9.153	***
American Indian	.012		-7.125	*
Asian/Pacific Islander	-.032		-.165	
Hispanic	.215		-4.214	*
Other, Unknown	-.320		-1.051	
Prop. Free/Reduced Price Lunch	.211		-3.699	
Math Rem.Llevel	-.130	***	1.075	***
Comm. Rem. Level	-.354	***	3.229	***
Intent-Premajor	-.277		-7.133	*
Intent-Vocational Deg./Cert.	.510	**	2.589	
Intent-Other/Nondeg./Blank	1.030	***	-23.042	***
Non-participant	-.090		-22.255	***
RS participant	-.646		14.102	*
High School Engagement	.010		-.375	

Note. For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.

For degree intent, transfer associate is used as an anchor and all other intent categories are compared to it one by one.

For participant groups, CIS DC is used as an anchor, and RS and non-participant groups are compared to it one by one.

Terms after High School: Adjusted $R^2 = .075$, and the regression function is significant: F (16, 6488) = 34.182***.

For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .000$; F not significant. For the comparison of RS and non-participant groups, B = -.556: t (6488) = 1.288.

College Level Credits Earned: Adjusted $R^2 = .107$, and the regression function is significant: F (1, 6488) = 49.745***. For the test of an interaction between CIS DC participation and high school engagement: $\Delta R^2 = .000$; F (1, 6487) = .050. For the comparison of RS and non-participant groups, B = 36.353: t (6488) = 9.143***.

*$p < .05$, **$p < .01$, ***$p < .001$

Attainment of Postsecondary Degrees and Certificates

Table 32 shows the distributions of degree or certificate attainment for the three groups. The majority of students in all three groups did not attain a credential, but when credentials were attained they were overwhelmingly transfer degrees.

Table 32.
*Degrees or Certificates Earned by CIS DC, RS, and Non-participant Groups (*N *= 6505)*

		Degree types				
		None	Certificate	Tech associate	Transfer associate	Total
CIS DC	Count	37	0	0	10	47
	%	78.7%	.0%	.0%	21.3%	100.0%
RS	Count	54	0	5	22	81
	%	66.7%	.0%	6.2%	27.2%	100.0%
Non-DC	Count	5197	36	49	1095	6377
	%	81.5%	.6%	.8%	17.2%	100.0%
Total	Count	5288	36	54	1127	6505
	%	81.3%	.6%	.8%	17.3%	100.0%

Table 33 provides the results of a logistic regression analysis predicting attainment of a degree or certificate from the independent variables and covariates used before. Students who participated in either CIS DC or RS were more likely to have earned a degree or certificate than were non-participants, but no difference was found between CIS DC and RS students. The level of engagement of a student's high school in the IT/CIS transition program did not affect the likelihood that the student would earn a credential, nor was there an interaction effect between high school engagement and CIS DC participation on credential attainment.

Older students were more likely to have earned a credential than were younger students, which is not surprising since they had had more time to do so. Men were less likely to have earned a credential than women, and African American and American Indian students were less likely than white students to have done so. Students with higher remedial levels in both math and communication (indicating less remedial need) were more likely to have earned credentials than were those with lower levels. Also, those with intentions of pre-majoring, or with no degree intentions at all, were less likely to earn a degree/certificate than were those who planned to earn a transfer degree. These effects are all consistent with the findings on college-level credits earned.

Table 33.
*Logistic Regression of Earning a Degree or Certificate on Student Characteristics, High School SES, Math and Communication Remedial Levels, Degree Intent, CIS DC and RS Participation, and High School Engagement (*N *= 6505)*

Variable	*B*	*SE B*	Exp(B)	
Age	.364	.022	1.439	***
Male	-.478	.070	.620	***
African American	-.580	.156	.560	***
American Indian	-.607	.308	.545	*
Asian/Pacific Islander	-.136	.110	.873	
Hispanic	-.153	.143	.858	
Other, Unknown	-.316	.185	.729	
Prop. Free/Reduced Price Lunch	-.192	.351	.825	
Math Rem. Level	.146	.021	1.158	***
Comm. Rem. Level	.263	.057	1.300	***
Intent-Premajor	-.758	.277	.469	**
Intent-Voc. Deg./Cert.	-.013	.120	.987	
Intent-Other/Nondeg./Blank	-1.604	.168	.201	***
Non-Participant	-.854	.377	.426	*
RS Participant	.294	.444	1.341	
High School Engagement	-.005	.016	.995	
Constant	-4.073	.483	.017	***

Note. For the model, $x^2 = 599.490$***, $df = 16$.
For the test of an interaction between CIS DC participation and high school engagement: $x^2 = 1.639$, $df = 1$.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For degree intent, transfer associate's degree is the anchor, and all other groups are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and all other groups are compared to it one by one.
For the comparison of RS and non-participant groups, $B = 1.148$***, Exp(B) = 3.151.
*$p < .05$, **$p < .01$, ***$p < .001$

Terms to degree was examined for students who earned a transfer associate degree. Speed of earning a technical degree would allow a better test of the utility of the CIS dual credits, but only 54 of the 1181 students who earned a degree earned it in a technical field and no CIS DC student did so. Table 34 presents a linear regression model predicting the number of quarters of enrollment at the target community college after high school before receipt of the associate degree, using the same independent variables and covariates as before. The model explained about 36% of the variance in terms to the degree. CIS DC students did not differ from non-participants, but RS students took about three quarters less than CIS DC students, and about 1.6 quarters less than non-participants, to achieve their degrees. We hypothesize that some of the dual credit earned in CIS would not count toward a transfer degree, while the academic dual credit earned by RS students would be more likely to fit into the transfer degree program. It is reassuring to see that the RS program did accelerate progress toward transfer degrees, as it was purported to do.

Table 34.
*Linear Regression of Terms to First Transfer Associate Degree on Student Characteristics, High School SES, Math and Communication Remedial Levels, CIS DC and RS Participation, and High School Engagement (*N *= 1127)*

Variable	*B*	*SE B*	*x*	*t*	
(Constant)	13.636	.909		14.994	***
Age	.592	.046	.323	12.898	***
Male	.023	.130	.004	.179	
African American	.123	.316	.010	.390	
American Indian	-.290	.603	-.012	-.482	
Asian/Pacific Islander	.360	.204	.044	1.759	
Hispanic	.158	.274	.014	.577	
Other, Unknown	.095	.349	.007	.272	
Prop. Free/Reduced Price Lunch	.767	.664	.032	1.155	
Math Rem. Level	-.500	.047	-.277	-10.603	***
Comm. Rem. Level	-1.228	.121	-.265	-10.137	***
Non-participant	-1.270	.666	-.082	-1.907	
RS participant	-2.917	.792	-.156	-3.681	***
High School Engagement	.004	.030	.004	.131	

Note. Adjusted R^2 = .361, and the regression function is significant: F (13, 1113) = 50.10***.
For the test of an interaction between CIS DC participation and high school engagement: ΔR^2 = .000; F not significant.
For ethnic groups, white group is used as an anchor, and all other groups are compared to it one by one.
For degree intent, transfer associate is used as an anchor and all other intent categories are compared to it one by one.
For participant groups, CIS DC is used as an anchor, and RS and non-participant groups are compared to it one by one.
For the comparison of RS and non-participant groups, B = -1.646 (t(1113) = -3.59***).
*$p < .05$, **$p < .01$, ***$p < .001$

As with most other analyses, high school engagement in the IT/CIS transition program was not a significant factor in the length of time it took students to earn transfer degrees, and there was no interaction between high school engagement and student participation in CIS DC. Only three covariates had significant effects: older students took longer, on average, than did younger students, and students needing more remediation in math or communication took longer as well.

In sum, there is no evidence in these data that engagement of the high school in the IT/CIS transition program affects students' credential attainment. However, both the CIS DC and the RS program appear to have facilitated the attainment of degrees and certificates. The RS program also appears to have advanced students toward the transfer associate degree more than the IT/CIS transition program did, but again, this is not surprising given the emphasis of the program on academics. There was no evidence of an interaction effect between participation and high school engagement level.

Follow-Up Survey

Contact information was provided for 105 students in the Northwest site; of these, 78 or 74% responded. Survey respondents were compared to the full sample to investigate biases introduced by the small number of surveys received. Females were 55.1% of the survey respondents but 42.3% of the full sample. In the full group, 67.8% were white, compared to 80.8% of respondents. The full sample mean age was 22.6 compared to 21.8 years for respondents. Thus, respondents included more younger, female, and white students than overall.

Students reported whether they had taken dual credit courses while in high school and indicated whether they had taken academic, CIS/IT, and/or other technical and career courses (see the survey in Appendix E). These equated to RS, CIS DC, and other CTE DC. For analysis, students were grouped as having taken CIS DC with or without RS or other CTE DC, having taken RS but not CIS DC, and having taken neither. Twenty-six had taken CIS DC, 17 had taken RS, and 35 had taken neither program. Survey results were analyzed around these three groups.

Demographic Characteristics and High School Achievement. Table 35 displays self-reported family background, high school and college performance variables, and employment outcomes, including students' ratings of the usefulness of their high school and college classes to their current jobs. The percentages of students who were white was not tested due to small expected frequencies, and there were no significant group differences on any of the other variables.

Concerning college participation, 66 reported having attended the target community college. The number reporting attendance is low, given that all students in our sample earned credit there during high school. However, since the college level CIS DC courses are taken at the high school, a student might not consider this as attending the community college, even if earning credit there.

Forty students (53.3% of the 75 students who reported) attended 2-year programs only, 7 students (9.3%) attended four-year programs only, and 28 students (37.4%) took a mix of two-year and four-year programs. The high enrollment in 2-year programs is not surprising, given that the sample was a subset of the students who had records at the target community college. Table 35 reports the number of college credits earned and the GPA, and again there are no significant group differences, but the non-participants tended toward fewer college credits and lower college GPAs. Table 35 also reports that 29 of 70 respondents had received no college credential, but 41 had received a certificate or associate's degree. Of these, 10 had also received a bachelor's degree. It should be noted that of those who report earning a credential, very few (4.3%) report an Associate of Applied Science (AAS) degree, while a much larger number (34.3%) report a transfer degree. This is consistent with the findings for the full sample, in which 17.3% earned a transfer degree while .8% earned a vocational degree.

Table 35.
*Family Background, High School, College, and Employment Variables of Survey Respondents (*N *= 69 to 77)*

	CIS DC		RS		Non-participant		Total	
	Count		Count		Count		Count	
Percentage White	25	88.0	16	81.3	35	80.0	76	82.9
Family Income Percentage <$60,000	25	36.0	14	57.1	30	63.3	69	52.2
Parental Educational Level, Mean	25	4.92	17	4.88	35	4.49	77	4.71
High School GPA	26	3.41	17	3.55	30	3.36	73	3.42
Total College Credits, Mean	25	98.84	14	102.43	30	79.63	69	91.22
Self-reported GPA in College, Mean	26	3.21	16	3.20	33	3.07	75	3.14
Percentage Earning College Credentials	20	50.0	17	64.7	33	60.6	70	58.6
Percentage Employed Part- or Full-time	26	80.8	16	75.0	35	71.4	77	75.3
Percentage of Employed with Entry Level/Unskilled or Semi-skilled Job	21	81.0	13	76.9	25	64.0	59	72.9
Hourly Rate of Pay in Primary Job, Mean	21	11.10	12	13.12	24	11.18	57	11.56
Usefulness of Material Learned in High School, Mean	21	1.14	13	0.69	25	1.48	59	1.19
Relatedness of College Classes, Mean	21	1.19	13	1.46	24	1.67	58	1.45

Note. For family income level, $x^2(2) = 4.26$, not significant.
For parental educational level, F (2, 74) = 1.11, not significant. Value 4 represents some college, and 5 represents an associate's degree.
For high school GPA, F (2, 70) = 0.82, not significant.
For total college credits, F (2, 66) = 1.32, not significant.
For self-reported GPA in college, F(2, 72) = 0.45, not significant.
For whether a student has earned college credentials, $x^2(2) = 0.93$, not significant.
For present employment status, $x^2(2) = 0.70$, not significant.
For present job type, $x^2(2) = 1.80$, not significant.
For hourly rate of pay in primary job, F (2, 54) = .64, not significant.
For usefulness of material learned in high school, F (2, 56) = 2.10, not significant. In the coding of the usefulness, 0 stands for "not at all", 1 stands for "somewhat", 2 stands for "fairly", 3 stands for "very", and 4 stands for "extremely."
For relatedness of college classes, F (2, 55) = 0.60, not significant. In the coding of the relatedness, 0 stands for "not at all", 1 stands for "somewhat", 2 stands for "fairly", 3 stands for "very", and 4 stands for "extremely."

There was no significant difference among the groups in the proportion who earned a credential. Overall, nearly 60% had earned a certificate or a vocational or transfer degree. Since students were identified as having attended the target community college sometime between fall 1998 and spring 2004, some would not have had time yet, a minimum of one or two years, to have achieved a certificate or degree. Thus a 59% attainment rate seems quite satisfactory. However, the attainment rate in the full sample was 19%, not 59%. Some of this difference would probably be due to the fact that survey respondents reported on degrees and certificates earned anywhere, but for the full sample records of degrees and certificates earned at the target community college only were available. In addition, the survey took place in the spring of 2005, while the community college records stopped a year earlier.

Table 35 shows that 75.3% reported being employed at the time of the survey, largely (72.9%) in entry level or semi-skilled jobs. There were no significant differences among the groups in employment rate, job type, or salary levels. Finally, Table 35 indicates that students did not find their high school learning very useful to their current jobs, with most groups' responses averaging around 1, or "somewhat useful." This is not surprising since the jobs seem to be quite low level and probably would not require substantial skills or competencies acquired in academic or technical coursework. There were no significant differences among the DC groups in the usefulness of high school learning, and college classes were only slightly better related to the current job. The differences among the groups were, again, not significant.

High School Transcript Analysis

Table 36 provides information from the analysis of high school transcripts for the 71 students in the Northwest site with both surveys and transcripts. Evaluation of the transcripts allowed comparison of the academic strength of the high school curriculum experienced by students in the various dual credit participation groups. There were no significant group differences in high school GPA means, although non-participants were the lowest of the three groups. Actual high school GPA means were consistently about .2 lower than those reported on the survey by the three groups.

The groups differed in mathematics progress. All three groups completed an average of algebra 2 or higher, with CIS DC students averaging about one level higher by taking a course such as trigonometry. Follow-up tests revealed that the CIS DC students progressed significantly further in math than did non-participants. There were no significant group differences in science, and all groups averaged at least a biology course. There were no significant differences in English or foreign language either, with all groups averaging four years of regular English and at least a half year of 10th grade foreign language. In none of the four pipelines did the CIS DC students trail others in achievement. However, only 5% (one student) who took CIS DC courses completed a full college preparatory program, compared to 18% overall. Group differences in college prep completion were not tested due to low expected frequencies, but it seems fair to summarize these results by saying that the CIS DC students tended to opt out of college prep, but they were as well-prepared as others in terms of progress in math, English, science, and foreign language.

Table 36.
*High School GPA; Progress in Mathematics, Science, English, and Foreign Language Pipelines; and Completion of College Prep Program for DC Participation Groups (*N *= 71)*

		CIS DC *N* = 20	RS *N* = 17	Non-Participant *N* = 34	Total *N* = 71
1	High School GPA	3.21	3.37	3.15	3.22
2	Mathematics Pipeline	6.20	6.00	5.24	5.69
3	Science Pipeline	3.50	3.94	3.29	3.51
4	English Pipeline	4.05	4.29	4.21	4.18
5	Foreign Language Pipeline	1.78	1.91	1.75	1.80
6	Completion of College Prep Program, Percentage	5.0	23.5	23.5	18.3

Note. For high school GPA, F(2, 68) = 0.62, not significant. Student GPA is reported by their school district, ranging from 0 to 4.
For mathematics pipeline, F(2, 68) = 3.65*, p = 0.03. Using Tukey post hoc tests, only one comparison is significant: the comparison between CIS DC and non-partcipants. In math pipeline codes, 5 stands for middle academic II (algebra 2), 6 stands for Advanced I (college algebra trig, statistics, linear algebra, etc.), and 7 stands for Advanced II (precalculus).
For science pipeline, F(2, 68) = 1.11, not significant. In science pipeline codes, 3 stands for general biology I, secondary life sciences (ecology, anatomy, etc.), general biology II, etc., 4 stands for chemistry I or physics I, and 5 stands for chemistry 1 and physics I.
For English pipeline, F(3, 68) = 0.38, not significant. In English language codes, 1 stands for 75% or more English credits taken were at low-level; 2 stands for 50% or more (not more than 75%) English credits taken were at low-grade; 3 stands for not more than 50% of English credits taken at low-grade and with no honor-level credits. 4 is primarily students with no low level and no honors courses.
For foreign language pipeline, F(2, 68) = 0.10, not significant. In foreign language codes, 1.0 stands for completed 1 Carnegie unit of 9th-grade language instruction, 1.5 stands for completed .5 Carnegie units of 10th-grade language instruction, 2.0 stands for completed 1 Carnegie unit of 10th-grade language instruction, and 2.5 stands for completed .5 Carnegie unit of 11th-grade language instruction.

In sum, with a small sample responding to the survey and releasing their high school transcripts, few differences were significant among the DC participation groups. However, non-participants tended to include more non-white students, with lower parental education. They also tended to report fewer college credits. Of the entire sample, three quarters reported that they were employed, though largely at entry-level jobs. Neither high school nor college classes were much related to these jobs. Almost all reported attending college. The three participation groups were not significantly different in most aspects of high school preparation. However, the CIS DC participants progressed further in mathematics than did non-participants ($p < .05$). In science, English, and foreign language, the CIS DC group mean was in the middle or near the high end in progress compared to the others, yet they were relatively low in rate of completion of a college prep program. It seems fair to conclude that the CIS DC students were about as well prepared as others in these aspects of the curriculum, even though they tended to opt out of college prep.

In conclusion, in the primary analyses, using the entire sample of 6505 students who earned credit at the target community college, no evidence was found that engagement of the high school in the IT/CIS transition program had an effect on students' performance, persistence, or credential attainment in higher education. Where there was an effect, it was on remediation, with students from higher engaged high schools seeming less ready for college, probably a selection bias. For no dependent variable was there evidence of an interaction between student participation in the CIS DC option while in high school and the degree of the high school's engagement.

CIS DC students were more likely to be college ready than non-participants in communication but not in mathematics or overall. But the CIS DC students started at a higher level, on the average, in mathematics but not communication than did the non-participant group. Thus, there is some evidence that CIS DC participation may have been associated with better college preparation than was non-participation. Our inability to control for academic achievement level, however, due to lack of information about high school performance, lessens the certainty with which we can conclude that dual credit participation had a positive effect. However, the importance of the level of remediation needed to subsequent outcomes is underscored by the significant effects both mathematics and communication remedial levels had on GPAs, college level credits and credentials earned (both positive), and terms enrolled, as well as terms to the transfer degree (both negative). Students with heavier remedial need are likely to enroll longer but earn fewer credits with lower grades, and are less likely to attain credentials than are others.

With remedial level (as a proxy for high school achievement) controlled, CIS DC and RS students both had higher college credit hours earned, and here RS students were also higher than CIS DC students. Both DC groups earned substantially more college credit than did the non-participants—36 credit hours for the RS group, and 14 for the CIS DC group. At the same time there were no group differences in the number of post high school terms during which these students enrolled. Thus, both DC programs appeared to be offering opportunities for amassing substantial credit that might accelerate a student's progress toward a degree. Indeed, the comparison of number of post high school terms to a transfer associate degree showed that the RS group was substantially faster than the CIS DC or non-participant group, by three quarters for the RS group and more than one quarter for the CIS DC students. In addition, both DC groups were more likely to earn a degree or certificate than were the non-participants. In short, these dual credit programs appear to be succeeding at their goals of accelerating students' progress through college and enhancing the likelihood of accelerating their attainment of credentials.

Some additional evidence about these programs was available in the smaller sample of approximately 70 students for whom survey responses and high school transcripts were available. This smaller data set allowed a detailed look at students' preparation for college while in high school, and revealed that while the CIS DC students tended to opt out of the college preparatory program, they were nonetheless about as well prepared as RS and non-participating students in terms of progress through the foreign language, English, and science curriculum. In mathematics, they progressed significantly further than did the non-participants. Thus, the acceleration these students were able to achieve in the technical field was coupled with solid academic preparation. This evidence suggests that these students had the benefit of CTE preparation but they were also reasonably well prepared to pursue other academic fields, if they chose not to continue their earlier interest in the CIS area. These findings can be viewed as positive, and they encourage continued emphasis on dual preparation in CTE and academics.

Southeast Site: Method

Because of a restrictive interpretation of the 1972 FERPA legislation, the Southeast community college provided only some demographic and enrollment information for approximately 3,600 students from 8 target secondary schools. Demographic information included date of birth. Enrollment information included whether or not students were enrolled in terms from spring 2001 to spring 2004, their majors at the beginning and end of this period, and degree or certificate. Records were identified concerning the high school attended by the student, split into those offering the EMT program and those that did not offer this dual credit transition program. Because the data were provided more than a year after the request, it was impossible to approach students for transcripts or to conduct a survey before the study concluded. Additional problems were that, contrary to our request, data were provided for students who were continuously enrolled throughout the study period, and the dates of degrees awarded were also not provided.

To investigate the research questions (whether EMT students and non-EMT students at high schools offering the program or students from schools offering the EMT program and those from schools with no EMT program differed in their rates of majoring in health fields or in credential attainment), the analysis was limited to students born in 1983 through 1986, the years in which the EMT students were born. The full sample included a number of much older students, whom we judged not to be comparable. Birth year was controlled in the analyses.

Independent Variables

Participation in the CTE Pathway Program. Participation was defined as enrollment in the EMT-Basic transition program during high school.

High and Low Engaged CTE Transition Programs in the Southeast Site. Schools were identified as high engaged if they offered the EMT-Basic transition program and as low engaged if they offered a health alliance program without transition-oriented collegiate-level curriculum but not the EMT-Basic transition program.

Southeast Site: Results and Discussion

EMT Students

Students could earn an EMT certificate while in high school by participating in the EMT program. The entire group of 127 students who participated in the EMT program while in high school, either designated by the program director or identified in the electronic records, was scanned for degrees or certificates earned. Table 37 provides the results.

Table 37.
Degrees and Certificates Earned by DC EMT Students

Degree or Certificate	Number	Percentage
None	66	52.0
Certificate	60	47.2
Associate Degree	1	0.8
Total	127	100.0

Nearly half of the EMT students earned a credential, almost all certificates. This compares favorably to the 10.3% of the non-EMT students from the same high schools who earned a credential. Since the latter group was continuously enrolled, and some of the EMT students were not enrolled continuously or even enrolled at all after high school, this comparison is quite favorable for the EMT program. Apparently, many participants completed the program and earned certificates.

Table 38 shows the number of students who enrolled at the community college after participating in the EMT program. This information is available only for the 88 participants identified by the program director, who also provided information about high school class that allowed determination of whether the community college enrollment was after high school. Less than one-third of the group (28%) continued to the community college after high school graduation.

Table 38.
Post High School Community College Enrollment by EMT Students

Enrollment Status	Number	Percentage
None	63	71.6
Enrolled	25	28.4
Total	88	100.0

Information about major field was limited, since only 8-28% of participants listed majors, depending on the term. Of those 25 students who were identified by the program director as participating in EMT from 2002 through 2004 and who subsequently attended community college, only 10 identified major fields. Of those, three, or 30%, majored in a health field after high school.

Comparison of Continuously Enrolled EMT Participants and Non-Participants

Table 39 indicates that continuously enrolled EMT students had substantially higher odds than did continuously enrolled non-EMT students from the same high schools, with birth year controlled, of earning a certificate or a degree and also had higher odds of majoring in a health-related field at some point. Older students were also more likely to have earned a credential than were younger students. Again, these results suggest that the EMT program was succeeding in credentialing students and possibly in keeping them in a health pathway. However, both questions were muddied by the lack of desirable covariates such as measures of high school achievement and SES (due to the fact that college records and high school transcripts were not made available for this research as had been anticipated). In addition, the health majors of some of the EMT students may reflect their major while in high school, as it was only possible to check this for those 88 EMT students on the program director's list.

Table 39.
*Logistic Regression of the Attainment of a Degree or Certificate and Health Major on Birth Year and DC-EMT Participation (*N *= 1233)*

	Credential Attainment		Health Major	
Variable	*B*	Exp(*B*)	*B*	Exp(*B*)
Birth Year		.484 ***	.172	1.188
EMT Participation	2.836	17.050 ***	1.013	2.753**
Constant	57.782		-17.309	
x^2, df	79.453***, 2		21.518***, 2	

*p < .05, **p < .01, ***p < .001

Comparison of Students from High Schools Offering EMT to Students from Other High Schools

Controlling birth year, the odds of obtaining a credential at the community college were almost twice as high for students from high schools offering the program as students from the other high schools. However, when EMT participation was also accounted for, this difference disappeared (see Table 40). Thus, the effect on credential attainment was apparently limited to the students who participated in the program. Nonetheless, this is further evidence that the EMT program is succeeding in credentialing students.

Table 40.
*Logistic Regression of Attainment of a Degree or Certificate on Birth Year, High School Group, and EMT Participation (*N *= 1860)*

	Model 1			Model 2		
Variable	*B*	*SE B*	Exp(*B*)	*B*	*SE B*	Exp(*B*)
Birth Year	-.511	.138	.600 ***	-.721	.151	.486 ***
HS Group	.595	.247	1.812 *	.221	.260	1.248
EMT Participation				2.833	.310	16.996 ***
Constant	39.531	11.539		57.144	12.643	
x^2, df	21.518***, 2			92.372***, 3		

*p < .05, **p < .01, ***p < .001

The same approach was used to investigate the effect of attendance at a school offering the EMT program on likelihood of majoring in health. It seemed quite possible that the EMT program might spark interest in health fields in students beyond those enrolling in it. However, Table 41 indicates that the odds of enrolling in a health major for students from schools offering the program were only about half the odds for students from high schools without it. This difference persisted when EMT participation was controlled, suggesting that the effect went beyond the students who enrolled in the program. Whether the outreach to the EMT high schools by the college's EMT program staff was deliberate is unknown. What is known is that these schools were *not* feeding students into their health programs at the same rate as other schools. If this is the case, it could explain the negative school effect for the EMT program.

Table 41.
*Logistic Regression of Health Major on Birth Year, High School Group, and EMT Participation (*N *= 1860)*

	Model 1				Model 2			
Variable	*B*	*SE B*	Exp(*B*)		*B*	*SE B*	Exp(*B*)	
Birth Year	.296	.113	1.344	**	.274	.114	1.316	*
HS Group	-.529	.180	.589	**	-.617	.186	.539	***
EMT Participation					.982	.368	2.669	**
Constant	-27.106	9.520			-25.291	9.579		
x^2, df	15.805***, 2				21.749***, 3			

*$p < .05$, **$p < .01$, ***$p < .001$

In sum, these data are modest in their ability to support clear conclusions because, except for the 88 EMT students, they are restricted to continuously enrolled students and because control variables and dependent variables were not secured from the lead community college, as was planned at the outset of the study. However, even with these limitations, the data strongly suggest that EMT students secured credentials at higher rates than did students who did not participate in the EMT program while in high school. Concerning the effects of attendance at high schools offering the program, certificate or degree attainment did not appear to be affected for students other than those participating in the EMT program. On the other hand, students in these EMT-offering high schools were less likely to major in a health-related field than were students from the other high schools, an effect that went beyond students in the EMT program.

CHAPTER 4: CONCLUSIONS AND IMPLICATIONS FOR POLICY AND PRACTICE

This mixed method study examined the relationship between student participation in CTE transition programs, transition to college, and performance and retention in postsecondary education and employment. The study sought to understand secondary student matriculation to two selected community colleges involved in collaborative partnerships with K-12 and secondary districts having numerous high schools. The selected CTE transition programs, located in different regions of the country, aimed to provide students with curriculum extending from the secondary to the postsecondary level. The Northwest site offered curriculum in Information Technology/Computer Information Sciences (IT/CIS), and the Southeast site provided two distinct CTE programs in Health Alliances, an Emergency Medical Technician (EMT) program and a Patient Care Assistant (PCA) program. This chapter summarizes the findings across the secondary and postsecondary components of the study (presented in Chapters 2 and 3, respectively) and suggests implications for policy and practice.

Major Findings and Implications

Through qualitative case studies and quantitative analyses of students' high school transcripts, standardized test scores, survey data, and college transcripts, this study examined the effectiveness of CTE transition programs. The secondary component of the study compared CTE and non-CTE students' academic experiences, achievement, and transition into the first semester of college. The postsecondary component of the study examined the transition pathways and related experiences of postsecondary students who had transitioned from high school CTE transition programs to the local community college. The academic performance and transition to college and career of CTE transition program participants and non-participants are discussed below.

High School Performance

Although CTE and non-CTE students did not differ significantly in their overall grade point average at high school graduation, secondary CTE students scored significantly higher than their matched non-CTE counterparts on the Reading for Information subtest of the ACT WorkKeys. As reported on the high school exit survey, CTE students also participated in more work-based learning and contextual learning than their non-CTE counterparts. Through these experiences, CTE students may have been more likely than non-CTE students to develop the ability to read and comprehend memos, letters, policies, and bulletins—all literacy skills required to do well on the Reading for Information subtest of ACT WorkKeys. There were no significant differences between CTE and non-CTE students in their high school academic course-taking, including math and science, although CTE students did earn significantly more CTE credits than non-CTE students. High school exit survey results also showed that CTE and non-CTE students' school experiences differed. CTE students were more likely to have engaged in contextual learning, participated in internships, had a mentor during high school, taken an industry certification exam, and participated in dual credit.

Findings from the postsecondary study echoed results of the secondary analysis, showing that IT/CIS dual credit (DC) students tended to opt out of the full college preparatory program, yet they were as well prepared academically as the students engaged in Running Start and non-participating students in terms of progress through the foreign language, English, and science curricula. Importantly, in mathematics, the IT/CIS DC students progressed significantly further than did non-participants. Thus, based on the secondary and postsecondary samples, policymakers and practitioners are encouraged to provide high school students with career pathway experiences, coupled with strong academic preparation.

Another implication for policymaker and practitioner consideration is the role that CTE programming may play in students' academic preparation. Both the secondary and postsecondary components of the study revealed that participation in IT programming was associated with increased math course-taking. Interaction effects indicated that IT students at medium engaged schools took significantly more math courses and attempted and earned significantly more math credits than their non-IT counterparts. A difference between IT and non-IT students was not evident at the high engaged schools, with the two groups attempting and earning a similar amount of math credit. Therefore, in high schools where CTE and academics had been integrated into the career pathway program, IT students and non-IT students did not differ significantly in their math course-taking, whereas at high schools where the career pathways were not a structural part of school programming, IT students were more advanced in math course-taking than their non-IT counterparts. Importantly, there was a main effect for CTE status for both high and medium engaged schools, with IT students taking significantly more math courses and attempting and earning significantly more math credits than non-IT students. This parallels the finding that IT/CIS students had progressed further in math at the postsecondary level than had others. However, unlike the high school findings, there were no interaction effects between high school engagement and student participation in the CTE transition program for any postsecondary outcome.

Facilitating the transition to college is an important area of focus for high school policymakers and practitioners. In addition to not compromising their academic preparation, CTE programming may have added benefits for preparing students for the transition into college and into a career. As reported on the high school exit study, CTE students felt more prepared for college and career than their matched non-CTE counterparts. Overall, CTE students were significantly more likely than non-CTE students to report that high school had provided them with information on college programs and courses that follow high school course-taking. At the end of high school, CTE students were also significantly more likely than non-CTE students to report having a clear career goal and a plan to achieve their academic goals. When asked about a series of skills, CTE students were significantly more likely than their non-CTE counterparts to report that they had developed problem-solving, project completion, research, math, college application, work-related, communication, time management, and critical thinking skills during high school.

Transition to College and Career

With respect to college attendance, CTE students were as likely as their matched non-CTE counterparts to enroll in college in the fall following graduation from high school. Half of the CTE students enrolled in college were attending a partnering college where they had earned credit during high school. This number did not differ significantly from non-CTE students who had enrolled in one of the target community colleges. The level of college attendance for high school CTE graduates at the Northwest site was equivalent to that found in the postsecondary study. Postsecondary analysis at the college level in the Northwest site compared post high school enrollment at the target community college for students who initially earned credits there through IT/CIS DC courses or through Running Start. One third of each group continued onto the target community college after high school.

CTE students were significantly more likely to be pursuing the career area that they had studied in high school than their non-CTE counterparts. Approximately 70% of CTE students were majoring in their career area (56% of IT students and 79% of health students). The postsecondary study also examined continuation in the career pathway from secondary school into the community college. Comparable to the finding for the secondary school sample, of those who attended the Northwest site's community college after high school, 55% continued in their IT/CIS pathway by taking at least one such course. Students matriculating to the community college who took CIS courses had a higher rate of self-reported intent to seek a vocational degree or certificate than did students who took no CIS at the community college. Thus, although CTE high school graduates did not transition into the target community college at higher rates than their non-CTE counterparts, they were more likely to pursue their career path than their non-CTE counterparts. This finding has important implications for policymakers and practitioners concerned with facilitating students' transition to college and into family-sustaining wage careers.

Concerning the need for remediation, follow-up survey results of secondary students revealed that few enrolled in remedial courses in their first semester of college, with no significant differences between CTE and non-CTE students. However, this finding should be interpreted with caution given that it is based on self-report data collected only a few months after participants had enrolled in college. Examining student records, the postsecondary study sheds more light on remediation. With other factors controlled, postsecondary study results showed that IT/CIS DC students were more likely than the non-participants to be college-ready in communication but not in mathematics or in general. With respect to the need for remediation, IT/CIS DC students started at a higher level than the non-participant group, on average, in mathematics but not in communication. Thus, the IT/CIS students were apparently better prepared in both areas than were the non-participants. However, unlike the self-reported secondary results, many students took remedial courses. Of the entire sample, a full 64% took at least one remedial math course, 36% took at least one remedial communication course, and 70% took at least one course of one or the other type. Students seem to continue and persist through college, even in the face of the need to take these courses. This finding has implications for how policymakers think about remediation courses, in that such courses may not have a negative impact on students' persistence through college.

There was also some evidence that IT/CIS DC participation may have been associated with better college preparation than was non-participation. However, academic achievement level could not be controlled due to the lack of information about high school performance of these students, lessening the certainty of a positive effect of IT/CIS DC participation. It is possible that the better students in these high schools chose to participate in dual credit, earning a grade of A or B to receive the credit, and it is their higher academic achievement that is reflected in the target community college record.

College Performance, Persistence, and Credential Attainment

In the Northwest site, where student records were available for analysis, IT/CIS and Running Start students both had more college credit hours earned, and Running Start students also had earned more college credit hours than IT/CIS DC students. Both the IT/CIS DC and the Running Start groups earned substantially more college credit than did the non-participants—36 credit hours for the Running Start group, and 22 for the IT/CIS DC group.

There were no group differences in the number of post high school terms during which these students enrolled. Both the IT/CIS program and the Running Start program appeared to be offering opportunities for amassing substantial credit that might accelerate a student's progress toward a degree. Running Start students moved substantially faster towards their transfer associate degree than the IT/CIS or non-participant students. Finally, both dual credit groups were more likely to earn a degree or certificate than were non-participants.

Both dual credit programs, the IT/CIS program and the Running Start program, appear to be succeeding at their goals of accelerating students' progress through college and enhancing the likelihood of credential attainment. Acceleration that these students were able to achieve in the CTE area was coupled with solid academic preparation. CTE preparation facilitated these students' progress toward a vocational degree or certificate in an IT/CIS field or toward a transfer degree in computer science. At the same time, they were reasonably well prepared to pursue other academic fields if they chose not to continue with their earlier interest in the IT/CIS field. Based on these findings, emphasis on the dual preparation in CTE and academic areas should be encouraged while also helping students accelerate their progress.

Despite serious data limitations in the Southeast site, there was a strong suggestion that students who took the college-level high school DC EMT program were earning credentials, primarily certificates, at higher rates than students who had not participated in the program.

Conclusion

As mentioned in Chapter 1, this study had several limitations. The findings should consequently be interpreted with caution. To better capture program effects, future studies should follow students longitudinally through the first two years of college at a minimum. This would increase the number of data points over time and account for college dropout rates. In order to avoid relying so heavily on self-report data, both high school and college transcript data should be collected to gain information on course-taking, including the need for remedial courses. Although the sample of programs was limited, engagement in transition programming does not appear to be a particularly potent variable for future study. While there were a number of interactions between high school engagement and student participation on secondary results, there was no interaction in terms of college outcomes.

Despite its limitations, this study reported several findings that may be valuable for policymakers and practitioners:

(1) Participation in CTE transition programming did not interfere with academic course-taking and there was some evidence that it fostered academic achievement.
(2) In addition, CTE transition programming led participants to feel more prepared for the transition to college and career.
(3) Importantly, dual credit played a role in participants' progress and success at earning college certificates and degrees.

These findings can inform high school reform efforts and the delivery of career pathway programs. CTE transition programming providing high school students with a dual focus on CTE and academic preparation can facilitate their transition into college and a career without hindering their academic performance. These programs can provide high school students with opportunities to earn dual credit in a career area and develop academic and employability skills that encourage their success in preparing for careers in high demand occupational areas during their college education.

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APPENDIX A. DISCUSSION OF LIMITATIONS

Limitations of this study are important to recognize, beginning with a limitation associated with the differences in selection of sites for the study and therefore the selection of study participants. Even though attempts were made to align site and participant selection criteria, researchers undertaking the secondary and postsecondary portions of the study found systematic differences in the educational institutions (and data provided by these institutions) that led to distinct sampling approaches. At the Northwest site, to be identified as a CTE transition program participant, high school students in the secondary school component of the study had to have taken a minimum of three courses from a range of IT offerings, while college participants were defined as students who earned a grade of B or higher in one or more secondary dual credit IT/CIS transition pathway courses. At the Southeast site, secondary student participants were those who enrolled in EMT-Basic or the PCA comparison program, while postsecondary participants were defined as those who had participated in the EMT-Basic transition pathway program in high school.

Another related limitation related to sample size. Even though the overall participant attrition was remarkably low among the secondary school participants, the subset samples in both the Northwest and Southeast sites were sometimes very small. Sample size issues were evident in some aspects of the postsecondary study as well, particularly in the number of students providing transcript and follow-up survey data in the Northwest site, and the number of CTE participants matriculating to the community college for which adequate student records were available in the Southeast site. Despite persistent efforts to collect data, the inability of researchers to gather data from students matriculating to the lead community college in each site represented a limitation of important consequence for the postsecondary component of the study.

For site recruitment, the possible number of prospective sites was limited to those institutions that had partnerships that met the criteria in the original *Sharing What Works* project. Within each site, the partnering secondary and postsecondary institutions had to offer the specified CTE programs, and all sites had to demonstrate a willingness to participate in the study. After accepting responsibility for undertaking the study, the secondary and postsecondary administrators were expected to fulfill their commitment to carry through on the study's expectations to share data. With respect to the Southeast site, this commitment was not met fully. In this site, some secondary administrators perceived the study as an evaluation of their school or unit rather than a research study having wider implications for policy and practice. At the postsecondary level, after agreeing to support the study, administrators disputed the study design, lagged in meeting timelines, and ultimately declined to provide the preponderance of the requested information.

Moreover, concerns for privacy and the perception that data sharing might influence college admission were cited by secondary students and their parents. Pertaining to the postsecondary research on students, researchers were unable to locate a sizeable number of students via various follow-up techniques. In addition, many students who were identified elected not to participate even when offered monetary incentives. To alleviate concerns at the secondary level, school counselors were recruited to be on-site liaisons. This strategy was not possible at the postsecondary level as students dispersed after high school, and there was no longer any central point of contact for them.

Another limitation involved the reliance on self-report data of students' high school experiences and transition to college and employment. Input from parents would have provided additional useful information, though resource limitations (time and money) precluded additional data analysis. Data on postsecondary students were limited to the information reported to the research team by the community college institutional research offices. In the Northwest site, the student data file provided by the community college offered an extremely comprehensive response to our data request; however, the Southeast site adopted a narrow interpretation of the institution's definition of "directory information." Also in Southeast site, the timing of the response to the request for student data extended over a one-year period, making it impossible to carry out the survey and transcript follow-up on individual students as had been done in the Northwest site. A complicating factor during the period of the study that contributed to the extensive delay was the region's suffering a serious hurricane.

A final limitation having enormous consequence to the study involved the researcher's inability to carry out a longitudinal study of the sort most appropriate to measure student matriculation patterns over time. This study began in August 2003 with completion planned for December 2004, providing a total of 17 months to carry out the entire project. Even with data collection beginning immediately upon the start of the project at the onset of the 2003-04 academic year, it was not possible to take a longitudinal approach because of the inability of the researchers to gather, analyze, and report findings by December 2004. As a consequence, the design called for intensive and complementary studies conducted simultaneously at the secondary and the postsecondary level. Even though a decision was made to extend the study from December 2004 to December 2005, this decision was made after the data collection was underway, and it was not possible to change the overall study design.

APPENDIX B. SUMMARY OF TRANSITION PRACTICES IN THE MEDIUM AND HIGH ENGAGED SCHOOLS

Transition Practices	High Engaged Schools	Medium Engaged Schools
Educational Partnerships	The district has a strong partnership with the intermediary organization and with county two-year colleges.	The district has a weak partnership with the intermediary organization and it has not developed strong partnerships with two-year colleges.
Program Recruitment and Retention Strategies	Students interested in IT choose to follow an IT-related career pathway. An award, Pathway Honors, is used to retain students in a career pathway.	Interested students enroll in IT classes. Guidance staff recommends IT classes to students struggling with the regular high school curriculum. There are no strategies to retain students in an IT transition pathway.
Career Pathways	Career pathways have been adopted. All high school students in the district declare a career pathway. IT programs are organized into clear sequences of courses.	Career pathways have not been systematically implemented. Students are not required to select a pathway. IT courses are not organized into clear sequences.
Articulation Agreements	There are many articulation agreements. IT instructors are engaged in the process of developing articulation agreements.	There are fewer articulation agreements. IT instructors are not engaged in the process of developing articulation agreements.
Dual Credit	Dual credit is an integral part of school programming. There are many dual credit course options available.	There are fewer dual credit course options. Dual credit is not an integral part of school programming.
Integration of CTE and Academics	CTE and academic learning have been integrated through the career pathways.	There is a distinction between CTE and college preparation. CTE and academic learning have not been integrated.
Advanced Course-taking	There are many advanced IT courses available. Students can take classes at any of the three high schools. There are no formal initiatives to ensure that IT students take advanced academic classes. Informally, IT students are advised to take advanced math classes.	There are fewer advanced IT courses available. There are no formal or informal initiatives to ensure that IT students take advanced academic classes.
Business Partnerships	There are strong partnerships between the high schools and the business community.	There are no strong partnerships with the business community.

Transition Practices	High Engaged Schools	Medium Engaged Schools
Work-based Learning (WBL)	There are many opportunities connecting experience in the workplace with academic learning. WBL is not a structured part of IT programming, but all students in the district have to complete a community experience, which often involves WBL.	There are WBL opportunities, but they are not connected to academic learning, and WBL is not a structured part of IT programming.
Mentoring	Students are required to find a mentor to supervise their community experience.	There are no formal mentoring initiatives.
Cohort/Small Learning Community	Small learning community grants are being used to implement advisory groups. Overall, students did not find these groups useful.	There are no formal small learning community initiatives.
Contextual Learning	CTE-driven initiatives, such as WBL and project-based learning, ensure that all students have an opportunity to engage in contextual learning.	Although there is not an effort to make contextual teaching and learning part of every student's experience, IT programming uses contextual learning.
Project-based Learning: Culminating Project	A culminating project is a graduation requirement for all students. Students reported that this project helped prepare them for the transition from high school more than any other school activity.	There is no culminating or senior project requirement.
Alignment with Industry Standards	Advisory committees, articulation agreements, an IT skills panel, and industry credentialing ensure that the IT curriculum is aligned with industry standards.	There are fewer articulated dual credit classes available, making the curriculum less aligned with industry standards.
Industry Certification	Students have the opportunity to prepare for A+, Microsoft, Certified Cisco Network Associate (CCNA), and Oracle SQL certification exams.	Students at both schools can prepare for the A+ certification exam. At DHS, students also have the opportunity to prepare for CCNA and one of the Microsoft certification exams.
Professional Development	CTE instructors are required to update their certificates every five years, and they must complete 2000 hours of work experience in their career pathway area.	IT instructors participate in industry internships.

Transition Practices	High Engaged Schools	Medium Engaged Schools
Leadership	There is evidence of strong leadership from the CTE director, school administrators, and IT instructors.	There is a lack of leadership support from the CTE director and school administrators.
Evaluation and Continuous Improvement	There is a commitment to evaluation and continuous improvement aimed at providing the best possible integrated education. An annual student survey on the career pathway initiatives is administered to improve the initiative.	Evaluation is based on state standardized tests. Reform initiatives are not focused on improving the career pathway initiative.
Guidance and Career Services	Guidance and career services are not connected to participation in CTE transition programs. However, IT students tended to access these resources more and found them more beneficial than non-IT students.	The guidance and career services offered are not connected to participation in CTE transition programs. Students did not find these services helpful.

APPENDIX C. SUMMARY OF PCA AND EMT TRANSITION PRACTICES

Transition Practices	Patient Care Assistant	Emergency Medical Technician
Educational Partnerships	The program does not have partnerships with regional community colleges. It has an informal understanding with one college.	The program has partnerships between high schools and the target community college.
Program Recruitment and Retention Strategies	High school counselors recruit students at the high school. Program outreach is done by the technical center through its high school coordinator.	High school counselors recruit at the high school. Program outreach is done through practicing EMTs and student-parent orientation.
Career Pathways	The program is identified within the health career cluster. Students navigate their own paths to postsecondary programs.	The program is identified as a pathway program with clearly delineated high school course sequences leading to postsecondary programs.
Articulation Agreements	There are no articulation agreements between the technical center and any community college.	Articulation agreements exist between the community college and the high schools.
Dual Credit	Dual credit is not offered. Students receive waived course units or hours or occupational completion points.	Dual credit is offered for course credits earned.
Integration of CTE and Academics	There are no formal strategies to integrate CTE and academics. Instructors try to integrate writing skills.	There are no formal strategies to integrate CTE and academics.
Advanced Course-taking	Instructors informally encourage students to take advanced CTE (health-related) courses. There are no formal initiatives to ensure that students take advanced academic courses.	Instructors informally encourage students to take advanced CTE (health-related) courses. There are no formal initiatives to ensure that students take advanced academic courses.
Business Partnerships	There are partnerships with regional hospitals through Health Science Advisory Committee.	There are partnerships with regional Emergency Medical Services facilities and hospitals.
Work-based Learning (WBL)	Students do clinical rotations at assisted living facilities and hospitals.	Students do ER rotations, participate in ambulance rides, and work at local hospitals.
Mentoring	There are no formal mentoring arrangements even though students are assigned a nurse supervisor at their workplace.	All students are assigned an EMT preceptor who guides them through their training and provides encouragement and support.

Transition Practices	Patient Care Assistant	Emergency Medical Technician
Cohort/Small Learning Community	There are no formal small learning community arrangements. However, students act like a community because they do their clinical rotations together.	There are no formal small learning community arrangements. Students take their lab instruction together but have separate clinical rotations. Students do not identify themselves as a community.
Contextual Learning	Students engage in contextual learning through role-play during lab instruction and WBL opportunities.	Students engage in contextual learning through role-play during lab instruction and WBL opportunities.
Alignment with Industry Standards	Accreditation and advisory boards manage program alignment to industry standards through their input in curriculum, district policy, and professional development for instructors.	Accreditation and advisory boards manage program alignment to industry standards through their input in curriculum and professional development for instructors.
Project-based Learning	Project-based learning approaches are not part of the PCA cluster program.	Project-based learning approaches are not part of the EMT transition pathway program.
Leadership	The program has a collaborative leadership structure that involves multiple stakeholders at the school district and industry levels.	Leadership is driven solely by the community college.
Industry Certification and Credentialing	Students take the PCA/CNA exam at the end of the program. Students who pass the exam become Certified Nursing Assistants.	Students take the National Registry Exam (for firemen and paramedics) on completion of the program to become certified EMT-Bs.
Professional Development	Professional development focuses on industry certification for teachers every two years.	Professional development focuses on teacher preparation to improve instructional delivery.
Evaluation and Continuous Improvement	Program administrators conduct student, employer, and student supervisor evaluations.	Program administrators conduct student, employer, and preceptor evaluations. (A state-mandated program review is required every five years.)
Guidance Services	Guidance services are not differentiated by program or CTE status. All students have access to the same guidance and career services. However, due to guidance staff having heavy student advisement loads, students may not receive adequate services.	Guidance services are not differentiated by program or CTE status. All students have access to the same guidance and career services. However, due to guidance staff having heavy student advisement loads, students may not receive adequate services.

APPENDIX D. COURSE CODING

Courses offered at the eight high schools and six junior high schools participating in the present study were coded in order to capture the information needed to answer the research questions. More specifically, a research objective was to identify the differences between Career and Technical Education (CTE) and non-CTE students' performance in math and science and participation in Work Based Learning (WBL).

The courses were first divided into four broad categories of Academic, Career and Technical Education (CTE), Military, and 'Other,' a category reserved mainly for physical education and art courses.

Academic Courses

Classified as Academic were courses from the subject areas of math, science, social studies, foreign languages, and English. Math and science courses were selected for further division into three difficulty levels: low, medium, and high. Math and science were of particular interest in this study as they are often part of the core subjects in high school (Castellano et al., 2004). Math was also chosen for further analysis since student achievement and participation in math has been shown to be an indicator of how well students perform in postsecondary educational institutions and the labor market (Castellano et al., 2003).

The division of the math and science courses into levels of difficulty was based on the examination of course guides of the eight high schools participating in the study, course content, and titles of the courses that the students in the study had taken.

Math

The identification of difficulty levels for the math courses repeated the division of math into low, medium, and high difficulty courses by Castellano et al. (2003). In general terms, math courses that preceded Algebra I in difficulty were considered low difficulty, and courses that were trigonometry-based or higher were considered high difficulty (Castellano et al., 2003).

Math courses that were classified as low difficulty either had no required course prerequisite (e.g., Applied Mathematics, Intensive Math), or were taught at a slower pace (e.g., Informal Geometry vs. Geometry). Also considered low difficulty were courses that were the first in a sequence of courses or that formed the base for more advanced courses (e.g., pre-Algebra, pre-Integrated Math).

The medium difficulty math category included all Algebra I courses (Castellano et al., 2003). It also included courses that were second or third in a sequence of courses (e.g., Integrated Math II, Integrated Math III, Algebra II), and courses that had a required course prerequisite (e.g., Geometry). Also included in the medium difficulty category were average difficulty courses that offered the possibility of dual credit, and that were not part of the core curriculum for graduation (e.g., Electronic Math Applications – Business Math). Dual credit courses like Math Analysis that were advanced in difficulty were placed in the high difficulty math category.

The high difficulty math category included all honors and advanced placement (AP) courses as specified in the course titles and identified in student high school transcripts (e.g., Algebra II Honors, Advanced Placement Statistics), as well as advanced level dual credit/dual enrollment courses (e.g., Trigonometry, Math Analysis, College Algebra, Pre-Calculus).

Science

Science courses were also split into three difficulty levels after examination of school course guides and course contents. The division was a modification of measures of difficulty for science courses as defined by Castellano et al. (2004). The Castellano et al. (2004) study divided science into four categories according to what the students participating in the study had taken in school. The schema identified students who took no science, low-level science (Basic Biology, Earth Science), middle-level science (general or Honors Biology), or advanced science (Chemistry and/or Physics) (Castellano et al., 2004).

For the purposes of the present study, an amended version of the Castellano et al. (2004) science categorization was used. Courses were divided into three levels: low, medium, and high difficulty science. The two middle levels of the Castellano et al. (2004) study (Earth Science, basic and general Biology) were merged into one low-level science category. The fourth category of the Castellano et al. (2004) study (Chemistry and Physics) was placed in the middle as medium level science, and certain dual credit courses, Advanced Placement courses, and Honors courses were categorized as high level science.

More specifically, courses placed in the low science category either had no required course prerequisite or formed the basis for more advanced courses (e.g., Biology I, Geology, Astronomy, Plant Science I, Earth Science, and Earth/Space Science).

Courses in the medium difficulty science category were more advanced in content and often built upon lower-level courses. Also in the medium science category were courses that offered the possibility of dual credit through an agreement with a corresponding college or vocational training program (e.g., Chemistry, Physics, Marine Science, Anatomy and Physiology, Marine Resources, Natural Resource Management).

The high difficulty science category included courses that were specified as Honors and Advanced Placement in the course title or student transcripts. Also included in the high difficulty science category were those courses that offered the possibility for students to take the course for dual credit (such as Anatomy and Physiology for some schools in the study). Other courses included in the high science category were Honors Anatomy and Physiology, Honors Physics, AP Chemistry, Honors Biology, and Advanced Chemistry.

English, Social Studies, and Foreign Languages

All academic courses that were not math or science (i.e. English, social studies, and foreign languages) were coded according to the school's classification of courses as determined by the course guides. An exception to the rule was made for Journalism courses that were often taken by students to fulfill English or elective requirements. Journalism courses were coded as either English or Specific Labor Market Preparation (SLMP under CTE) depending on the course descriptions at each school. If the course description emphasized writing, the course was coded as English. In the schools where the emphasis was on newspaper production, career exploration, and advertising, the course was coded as SLMP.

Career and Technical Education

Courses of Career and Technical Education (CTE) content were divided into Specific Labor Market Preparation (SLMP), General Labor Market Preparation (GLMP), and Family and Consumer Sciences (FCS) following the Secondary School Taxonomy (SST) identification of

CTE courses.

Specific Labor Market Preparation

SLMP courses were divided into five codes to capture general SLMP, Information Technology (SLMP-IT), Emergency Medical Technician training (EMT), Personal Care Assisting (PCA), and Other Health Related courses.

General SLMP

General SLMP courses—i.e., those that were not EMT, PCA, SLMP IT, or Other Health related—belonged to one of the eleven SLMP categories of the SST. Courses covering content of the fields of Agriculture and Renewable Resources, Business, Marketing and Distribution, Public and Protective Services, Trade and Industry, Technology and Communications, Personal and Other Services, Food Service and Hospitality, and Child Care and Education were all coded as SLMP. As there was variation from school to school in the course content for same or similar course titles, courses were split according to course description, not course title.

SLMP-IT

SLMP-IT courses for the Northwest schools were determined by the Pierce County Careers Connection complete IT course titles list (e.g., Web Design, CISCO, Programming, PC Hardware, Fundamentals of IT, etc.). For the Southeast site, the same courses were categorized as SLMP-IT according to course content (e.g., Business Computer Programming, Networking I, Digital Design, etc.).

EMT, PCA, and Other Health Related Courses

Courses coded as EMT were part of the Basic Certification Program Career Core Requirements (Fundamentals of Emergency Medical Care, Emergency Department Clinicals, and EMS Field Internship). Coded as PCA were the Patient Care Assisting I, II, and III and Patient Care Tech courses. The Other Health Related course category aimed to capture health related courses that students in the EMT and PCA track at the Southeast site may have taken that were related to their chosen CTE track. The code was applicable only to the Southeast schools where Health-related courses (EMT and PCA) were the CTE tracks of interest. Some examples of courses in the Other Health Related category were First Aid Safety, Advanced Health Explorations, Care and Prevention of Athletic Injuries, and Medical/Social Services Vocational Spanish. Courses that were the same or similar at the Northwest schools were included under the SLMP general code as IT was the CTE track of interest there.

General Labor Market Preparation

The General Labor Market Preparation (GLMP) course category was divided into four categories to capture 1) general GLMP courses, 2) Information Technology (GLMP-IT) courses, 3) Work Based Learning (WBL) for WA, and 4) WBL for FL. Two different codes were assigned for WBL so comparisons could be made in WBL patterns between the Southeast and Northwest schools.

GLMP courses (that were not IT or WBL) were those in the course guides described as a general introduction to a field (e.g., Marketing Essentials), general or specific career exploration courses (e.g., Careers, Technology Studies I), or training for skills needed in the general labor market (e.g., Business Systems and Technology).

Coded as GLMP-IT were courses that taught basic computer use and skills enhancement (e.g., Practical Computer Skills, Typewriting/Keyboarding, Microsoft Applications, Digitools, Business Software Applications).

Categorized as WBL were courses that offered school credit for working on or off school premises, and internships (e.g., TA Career Center, Peer Tutor, TA Office Assistant, Ed. Careers 1 and 2, Business and Marketing Internship, Cooperative Work Based Learning).

Family and Consumer Sciences

Coding for the Family and Consumer Science (FCS) courses followed the SST (Bradby & Hoachlander, 1999) closely. Coded as FCS were courses whose content related to students' personal development, consumer education, food and nutrition, and other content regarding activities outside of the paid labor market (Tuma & Burns, 1996). As course titles and content varied by school, course coding was based on the course descriptions in the course guides. For example, a course on Food and Nutrition may have belonged to either the FCS or SLMP category depending on the scope of the course (personal health choices versus food service career preparation). If the course description was one that described student preparation for careers in Food Service and Hospitality (a category from the SST under SLMP), the course was coded as SLMP. On the other hand, if the description highlighted personal choices in food and nutrition, the course was coded as FCS.

Military and Other Courses

All courses of the Naval Junior Reserve Officers Training Corps (NJROTC) or Junior Reserve Officers Training Corps (JROTC) were classified as Military.

The 'Other' category included courses in the Arts (Music and Fine Arts), Physical Education, and Home Based Education. Courses titled Yearbook, Orchestra, Leadership, Study Skills, and Learning Lab were included under the 'Other' category for coding purposes, as were unidentified transferred courses.

APPENDIX E. CTE POSTSECONDARY FOLLOW-UP SURVEY
Spring 2005

*Reimbursement checks for **$20**, upon receipt of your survey, will be sent to the address below. Please confirm and make any corrections.*

High School Experience

1. **Think back to when you first completed high school. How prepared were you to do the following?** *(Check the appropriate descriptor box for each line.)*

	Not At All	Somewhat	Moderately	Very	Extremely
a) Apply for and get into college	*0*	*1*	*2*	*3*	*4*
b) Apply for and get a job	*0*	*1*	*2*	*3*	*4*

2. **What was the last high school you attend?** ____

3. **Did you receive your high school diploma?** *1*) Yes *0*) No

4. **If No, did you receive your GED?** *1)* Yes *0*) No

5. **Dual credit courses are offered in the last high school you attended. These courses give college credit as well as high school credit. Using the categories below, please indicate if you took a class. If *Yes*, indicate the number of dual credit classes you took during high school in that subject.**

Subject	Completed? *Circle Yes or No*	Number of dual credit classes you completed in this subject during high school
(5A) Academic classes (math, science, English, history)	*1*) Yes *0*) No	*5a completed*
(5B) Computer Information Sciences and Information Technology courses (Fundamentals of IT, Introduction to Programming, Operating Systems)	*1*) Yes *0*) No	*5b completed*
(5C) Other professional, technical, and career courses (Business & Marketing, Health & Human Services, Arts & Communications)	*1*) Yes *0*) No	*5c completed*

6. **What was your final cumulative GPA at the time you graduated high school?** _________

7. **Think about *all* the math courses you took during high school. What would be your average report card grade for *all* of your math classes?** *(Circle one.) A B C D F I don't know (DK)*

8. **What was the highest math course you completed in high school?** ___________________

9. **In which grade did you take this math course?** *1)* 9th *2*) 10th *3)* 11th *4*) 12th

10. **Think about *all* the English courses you took during high school. What would be your average report card grade for *all* of your English classes?** *(Circle one) A B C D F I don't know (DK)*

11. **Did you take honors English/Language Arts courses in high school?** *1*) Yes. How many? ____*11 nbr*______ 0) No

12. **Think about *all* the science courses you took during high school. What would be your average report card grade for *all* of your science classes?** *(Circle one.) A B C D F I don't know (DK)*

13. **What was the highest science course you completed in high school?** _________________

14. **In which grade did you complete this science course?** *1*) 9th *2*) 10th *3*) 11th *4*) 12th

15. **List all of the Advanced Placement (AP) courses you completed in high school.**

1. ____
2. ____
3. ____
4. ____
5. ____
6. ____
7. ____
8. ____
9. ____
10. ____

Postsecondary Education

16. **Since high school, have you been enrolled in any college, university, or technical program?** 1) Yes 0) No *(skip to Current Employment section)*

17. **List the name of each college/university/technical program you have attended. Also include the location, start and end date of your enrollment, and the type of program.**

Full Name of College/ University/Technical Program	Location (City, State)	Start Date (mth/yr)	End Date (mth/yr)	Type (circle one)
Ex: San Diego Community College	*San Diego, CA*	*9/02*	*5/03*	*2-yr 4-yr Other:____*
1st name	*1st location*	*1st sdate*	*1st edate*	*2-yr 4-yr Other:____*
2nd name	*2nd location*	*2nd sdate*	*2nd edate*	*2-yr 4-yr Other:____*
3rd name	*3rd location*	*3rd sdate*	*3rd edate*	*2-yr 4-yr Other:____*
4th name	*4th location*	*4th sdate*	*4th edate*	*2-yr 4-yr Other:____*

18. **Was your *first* major field of study in college related to Computer Information Sciences (CIS) or Information Technology (IT) ?**
   1) Yes – please specify CIS or IT major: ________*18 major*__________________________
   0) No – please specify major: ________________*18 major*___________________________

19. **Was/Is your *last* major field of study in college related to Computer Information Sciences (CIS) or Information Technology (IT) ?**
   1) Yes – please specify CIS or IT major: __________*19 major* ________________________
   0) No – please specify major: ____________________*19 major* ________________________

20. **Over the entire time you have enrolled in college, how many college credit hours have you earned?** Total number of credit hours earned: __________

21. **What is/was your current/last cumulative numeric GPA in college?** __________

22. **Since high school graduation, which college credentials have you already received?** *(Circle all that apply.)*
   1) Certificate or license requiring less than a two-year degree
   2) Associate of applied science degree
   3) Two-year AS or AA degree for transfer to a four-year college
   4) Bachelor's degree
   5) Other: (please specify) ___________________________
   6) No college credential

23. **Which of the following college credentials are you seeking right now?** *(Circle all that apply.)*

1) Certificate or license requiring less than a two-year degree
2) An associate of applied science degree
3) A two-year AS or AA degree for transfer to a 4-yr college
4) A bachelor's degree
5) I am no longer seeking a college credential
6) Other: (please specify) ________________________

24. What is the highest level of education you plan to complete?

1) High school diploma
2) Technical certificate or trade school certificate
3) Associate's degree
4) Bachelor's degree
5) Master's degree
6) Doctorate (e.g., M.D., Ph.D., JD, etc.)
7) Other: (please specify) ________________________________

Current Employment

25. **What is your employment status at the present time?**

1) Unemployed and not seeking employment (skip to Background Information Section)
2) Unemployed, but actively seeking employment (skip to Background Information Section)
3) Employed - working part-time (less than 35 hours/week)
4) Employed - working full-time (35 or more hours/week)
5) Serving in the military full-time
6) Other: (please specify) ______________________

26. **Think of your primary job as the job that takes up the largest amount of time you spend working each week. Which of the following best describes your current primary job?** *(Check one.)*

√	Job	Description
	(1) Entry level/ Unskilled job	Minimal training is required and little orientation is provided by employers. Hiring is usually not very competitive.
	(2) Semi-skilled job	Usually requires 6 months to a year of specific training, college education or equivalent skills and experiences. Hiring is usually competitive.
	(3) Skilled/ Technical job	Usually requires 1-2 years of specific training or college education prior to being hired. Hiring is usually very competitive.
	(4) Professional job	Usually requires 2-4 years or more of training. College degree and/or state professional license/certification is often required. Hiring is usually extremely competitive.

27. **What month and year did you begin working in your primary job?** month____/year____

28. **What is your hourly rate of pay in your primary job?** $__________/hour

29. **How useful was what you learned in high school to your primary job**?
0) Not at all 1) Somewhat 2) Fairly 3) Very 4) Extremely

30. **How related are your college classes to your primary job?**
0) Not at all 1) Somewhat 2) Fairly 3) Very 4) Extremely

31. **Which of following job types best describes your ultimate career goal?** *(Check one.)*

√	Job	Description
	(1) Entry level/ Unskilled job	Minimal training is required and little orientation is provided by employers. Hiring is usually not very competitive.
	(2) Semi-skilled job	Usually requires 6 months to a year of specific training, college education or equivalent skills and experiences. Hiring is usually competitive.
	(3) Skilled/ Technical job	Usually requires 1-2 years of specific training or college education prior to being hired. Hiring is usually very competitive.
	(4) Professional job	Usually requires 2-4 years or more of training. College degree and/or state professional license/certification is often required. Hiring is usually extremely competitive.

Background Information

32. **What is your gender?** 1) Male 2) Female

33. **Are you of Hispanic origin or descent?** 1) Yes 0) No

34**. What is your racial/ethnic background?**
1) African American (Black)
2) Asian or Pacific Islander
3) American Indian or Alaska Native
4) Caucasian
5) Other: (please specify) ________________________

35. **What is the highest level of schooling your father/male guardian AND mother/female guardian completed?** *(Check one level of schooling for each parent/guardian.)*

Schooling	(35) **Father/Male guardian**	(36) **Mother/Female guardian**
1) Eighth grade or less		
2) Some high school (9th grade or higher)		
3) High school (including GED)		
4) Some college (no degree)		
5) Received Associate's degree		
6) Received Bachelor's degree		
7) Graduate/professional school after college		
8) Do not know, or does not apply		

37. **What was your total annual family income while you were in high school and living with your parent(s)/guardian(s)?** *(Approximately)*

1) $14,999 or less
2) $15,000 - $29,999
3) $30,000 - $44,999
4) $45,000 - $59,999
5) $60,000 - $74,999
6) $75,000 - $89,999
7) $90,000 or more (please estimate $______________)

THANK YOU!

A $20 CHECK WILL BE MAILED TO YOU UPON RECEIPT OF YOUR SURVEY.

Please return in the Self-Addressed Stamped Envelope to:

CTE Survey, P.O. Box 374, Jenison, MI 49429