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Developing the IT Workforce

Certification Programs, Participants and Outcomes in High Schools and Two-Year Colleges

Final Report

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EXECUTIVE SUMMARY

Many high school and two-year college vocational programs are exploring new ways to help students develop and document skills valued in the labor market. Over the past decade, some efforts to improve vocational programs have focused on reorganizing curricula around skill standards and assessments formulated by employers. One recent example of this trend is the Information Technology (IT) certification programs based on curricula and tests developed by IT companies such as Cisco, Microsoft and Novell. Some educators have suggested that these IT certification programs are attractive because they offer opportunities for students with various levels of academic achievement and postsecondary plans to earn valuable credentials. These programs could serve as a model for other efforts to improve vocational programs by developing assessments and credentials for jobs that do not require a four-year college degree.

To begin to describe and answer some of the basic questions about these programs, the U.S. Department of Education contracted with Mathematica Policy Research, Inc. (MPR) to conduct an exploratory IT Certification Study of Cisco, Microsoft and Novell programs in high schools and two-year colleges. The study is designed primarily to describe these programs, the students who participate and students' postprogram experiences. It was not designed to measure program effects. The three main data sources for the study are a national survey of IT schools, a survey of students who completed programs in 20 case study schools and extended interviews with staff members in case study sites. These data were collected in 2002.

The following discussion summarizes key findings relating to the design and resource needs of certification programs, the number and mix of students who have access to and participate in these programs, and participants' outcomes.

PROGRAM DESIGN AND RESOURCE NEEDS

The design of a school's IT certification program reflects local priorities and constraints. Although vendors define some of the basic program features, schools have discretion about which skills their courses cover and how instructors teach the material. A program's design can reflect the pedagogical objectives of the instructor, school or state. In some cases, programs may place the greatest emphasis on preparing for the certification test; in other cases, programs may seek to develop a broader set of IT-related skills. In addition to defining the learning priorities of the IT classes, schools interested in developing IT certification programs must determine how to meet the resource needs of these programs. Schools may need to purchase computers, cabling equipment, software, textbooks and teacher training.

The case study visits and staff interviews suggested that program designers face significant challenges and trade-offs. Our main findings on program design pertain to four types of challenges that program staff members face: (1) the ways high school programs try to balance certification preparation against other academic and vocational objectives, (2) how for-credit and non-credit college programs coordinate with each other while meeting diverse student needs, (3) issues related to developing hands-on activities and internship opportunities while seeking to

cover all the topics in the curriculum, and (4) the substantial investments in equipment and teachers' professional development that some programs must make.

- **High school certification programs have to compete with schools' other academic priorities for students' time.**

To prepare fully for certification tests, students have to master many technical skills. This effort can require a substantial amount of students' time. Most model IT programs range from one to two years. Because the model high school program is often time-consuming, some high school IT certification programs do not emphasize student mastery of all the material. Academic graduation requirements can limit the time available for IT certification classes. State IT vocational standards can require that schools offer introductory classes or broaden the certification class curriculum, which further reduces the time available to focus on the skills required by the IT certification tests. The National IT School Staff Survey indicates that more than one-third of high schools with Cisco and Microsoft programs and 16 percent of the schools with Novell programs do not offer all the classes needed to prepare a student for any certificate. Even when schools do offer the complete sequence of classes, they sometimes have difficulty filling higher-level courses, in part, because juniors and seniors must often focus on fulfilling state and local academic requirements.

Articulation agreements between high schools and community colleges can enable students who do not complete IT certification by the end of their senior year to continue their IT studies and earn certificates after they graduate. Nationally, most high schools with certification programs have these types of agreements with at least one local college. However, some IT articulation agreements remain limited in ways that may inhibit their use. For example, some agreements give high school students college credits in only one local college. To address this issue, some states are developing statewide articulation agreements that include most public two-year colleges in the state.

- **Some for-credit and non-credit college case study programs operate independently of each other and are designed to serve different needs, but some colleges see opportunities to coordinate these programs better.**

For-credit college IT programs and non-credit college IT programs tend to have somewhat different objectives. Most for-credit IT programs are designed to help students develop a broad background in IT and earn a degree (or a college certificate). By contrast, most non-credit IT programs are designed to help workers obtain specific skills and industry certificates.

The distinct purposes of for-credit and non-credit IT programs are reflected in the schedule of their classes and the flexibility of their curricula. For-credit IT certification classes typically follow the established college semester schedules at a pace suited for students with a limited IT background. Non-credit programs offer classes with a variety of schedules, ranging from a few weeks to an entire semester; these programs also offer both moderately paced classes and more accelerated classes. Although the content of for-credit IT certification classes is often shaped by

the demands of a broader program of study, non-credit IT classes tend to have more flexible curricula and can be developed more quickly. Many of the certification classes in the case study colleges first were offered as non-credit classes and subsequently were incorporated into the for-credit IT degree programs.

Despite their differences, for-credit and non-credit IT programs tend to use similar facilities and instructors with similar skills. If a college operates both types of programs, the programs can share faculty, facilities and curricula. This resource coordination can enable schools to achieve minimum class sizes, use equipment efficiently or offer a larger menu of classes.

However, some for-credit and non-credit programs operate independently of each other, with separate faculty, facilities and curricula. The interest of for-credit programs in ensuring that curricula meet internal and external academic standards sometimes conflicts with the emphasis of non-credit programs on responding quickly to labor market needs. Sometimes financial considerations reinforce the tendency to keep the two types of programs distinct. Some states provide Perkins funding only to for-credit programs, so colleges must ensure that these resources do not subsidize non-credit programs.

Better coordination and increased institutional flexibility might help some colleges' for-credit and non-credit programs prepare students for IT careers. College administrators may find it useful to encourage their for-credit and non-credit divisions to pool more resources, ensure that students are aware of course offerings in both areas and develop complementary programs. In addition, state and federal supporters of these programs may be able to encourage increased coordination by providing more flexibility in how colleges use grant funds or by broadening performance criteria to reflect the potential benefits of both for-credit and non-credit classes.

- **IT certification program staff members and students see a need for more hands-on activities and internship opportunities.**

As schools develop their IT certification curricula, they also need to adopt instructional strategies that are engaging and that help students master key skills. Most case study instructors sought to introduce hands-on activities to help students learn how to apply skills in realistic job tasks such as setting up the hardware and software for computer networks. During site visits, students and local employer partners reported that these activities were quite helpful.

However, limits on class time and instructor preparation time can make it difficult to assign enough hands-on exercises. These constraints sometimes prevented instructors from assigning lab exercises built into the model Cisco, Microsoft or Novell curricula. Some school staff members also commented that, despite the helpfulness of many of the Cisco and Microsoft labs, they would like to develop additional activities involving complex, real-world problems more similar to those that network administrators face. Some case study schools developed opportunities for student internships, but only a small portion of the students in the case study certification classes participated.

The experiences of the case study schools suggest that, if school staff members have enough planning time, they can cultivate relationships with external partners to expand internships and strengthen hands-on activities. The case study schools demonstrated the feasibility of developing internships by forging partnerships with IT vendors, non-profits, temporary-help firms and other local employers. Involving more students in these activities may require expanding staff efforts to reach out to employers and paring back other parts of the certification curriculum.

- **Computer equipment and teacher training can be substantial investments for IT certification programs.**

Before deciding to introduce a specific IT certification program, schools must consider the cost. A new program may require that schools buy computer equipment, instructional materials and training for staff members. The particular investments required to start a new IT program depend on a school's existing resources.

IT certification programs typically incurred significant costs for computer equipment. All of the case study schools reported purchasing some computer equipment for their programs. For most of these schools, computer equipment was the largest start-up cost. The average equipment expenditure was about $16,000 among case study high schools and $67,000 among colleges.[1] Although some schools saved on equipment costs by using PCs purchased for other purposes, older PCs could not always run new instructional software, and they ran other software slowly.

Many teachers in the case study schools were initially unfamiliar with the material or were new to IT and, as a result, needed substantial training before they could teach the certification classes. Many schools chose to retrain their teachers rather than hire new ones, partly because they had had difficulty recruiting teachers with the qualifications to lead the classes. Some teachers devoted significant amounts of personal time to their own training.

In estimating the resources needed to support programs, school staff members should make sure they consider the amount needed for new equipment and the time required for teachers to learn certification skills and keep programs up to date. Program quality could suffer if schools use out-of-date equipment. Administrators of schools that do not pay teachers for the time they devote to training should be aware of the risks of underinvesting in teachers' skills and of increasing teacher burnout.

STUDENT PARTICIPATION IN CERTIFICATION CLASSES

Many schools have sought to make vocational programs accessible and relevant to a broad student population. Vocational programs historically have been designed primarily for students

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[1]These estimates, based on reported costs from seven case study high schools and six case study colleges, may understate the actual costs of all the equipment students used, particularly among colleges that had many IT programs and may not have reported all equipment costs.

who want to enter the labor market shortly after completing high school. Educators generally agree that vocational programs should continue to be available to this group. In addition, some educators also have sought to make these programs more relevant to high-achieving students, particularly students who want not only to develop occupational skills but also to earn a college degree. The mix of students participating in IT certification programs, one of the fastest growing types of vocational programs, may point to future changes in the role of vocational education. Here, we first summarize findings on the prevalence and scale of IT programs and then examine the mix of students who participate.

- **IT certification programs are prevalent among both high schools and two-year colleges, but two-year college programs tend to serve more students.**

IT certification classes are now offered in many schools. By May 2001, a Cisco, Microsoft or Novell class was available in about 14 percent of all high schools and 25 percent of all two-year colleges. At the high school level, Cisco classes are much more numerous than are Microsoft or Novell classes. At the postsecondary level, all three types of classes are fairly common.

Most high school IT certification programs are of modest size, which suggests that they may attract a narrow segment of the student population. For school year 2000–2001, the median school responding to the IT School Staff Survey indicated that the total number of students enrolled in any of its Cisco, Microsoft or Novell classes was 24; the average enrollment level was 31 students.[2] About 0.5 percent of all high school students enrolled in at least one Cisco, Microsoft or Novell class. Although the size of the average high school program is modest and only a small portion of all high school students enter an IT program, a total of 92,000 U.S. high school students participated during the 2000–2001 school year. This enrollment level is larger than that of most other types of vocational programs based on industry-defined standards, including the Automotive Service Excellence (ASE) automotive repair programs.

College IT certification programs tend to be larger, in part, because colleges offer a broader menu of classes. In the median two-year college that offers at least one Cisco, Microsoft or Novell class, these classes enrolled about 102 students, and the average enrollment for a college was 250.[3] About 1.3 percent of all two-year college students, or approximately 270,000 students, took a Cisco, Microsoft or Novell class during school year 2000–2001.

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[2]These figures represent the combined enrollment in all classes. For high schools, it covers all grades. For colleges, it includes each class in the sequence designed to prepare students for certification.

[3]Excluding an outlier college that reported enrollment of 7,000 students in IT classes reduces the average IT enrollment to 217.

- **Case study high school programs serve mostly students who have moderate academic achievement levels, partly because programs screen out some low achievers and partly because few high achievers choose to participate.**

Several of the case study high schools have had high rates of attrition. For example, some Cisco programs lost about one-third of participating students during the first two semesters and another third between the first and second years. According to school staff members, some students who are initially attracted to programs do not have a clear sense of the curriculum or do not possess key skills.

As a result, after implementing an IT certification program for a year or more, some of case study schools decided to discourage students with very low math and reading grades from participating. Many students with low academic grades had dropped out because they could not handle the material, did not enjoy it or had to take many academic courses in their senior year to meet graduation requirements. Other schools required students to complete an introductory IT class; students with weaker grades could take the certification class as long as they completed the introductory IT class successfully.

While several case study schools discouraged the lowest-achieving students from participating, the highest-achieving students often chose not to participate. According to school staff members, some high-achieving students with an interest in IT were reluctant to enroll in the certification classes either because they attached a general stigma to vocational programs or because they perceived other classes to be more helpful in their preparations for college. The student survey in the case study sites also suggested that most participants had moderate academic achievement levels. The vast majority of students reported GPAs that clustered around a B. The survey, conducted two years after most case study students left high school, indicated that only about 48 percent of the IT program participants enrolled in college programs, most in two-year rather than four-year colleges. Nationally, a somewhat higher portion of students enroll in college within two years of leaving high school.

As schools seek to enhance IT certification programs, staff members may have to revisit whether and how to screen students. In the absence of any findings indicating which groups are most likely to benefit from certification classes, educators might try to explore ways of giving students with low academic grades some opportunities to participate, perhaps by offering more introductory IT classes in which students are expected to demonstrate their interest in IT and their ability to master key skills.

- **Black students and female students are underrepresented in IT certification classes.**

Some educators have suggested that IT programs should try to attract minority and female students because these groups are underrepresented in IT jobs. By breaking down stereotypes and preparing more minority and female students for IT positions, programs potentially can benefit not only these students but also employers who sometimes have difficulty identifying qualified candidates to fill IT positions.

Evidence based on the schools that minority students attend appears to show that minority students have at least as much access to high school and college IT certification programs as do white students. Among high school students in the United States, approximately 26 percent of all black students and 30 percent of all Hispanic students are enrolled in a school that offers a Cisco, Microsoft or Novell class, compared with 22 percent of white students. Among all students enrolled in community colleges, the portion of black and Hispanic students who attend schools that offer an IT certification class is close to the portion of white students attending one of these schools.

Relative to white students, however, both black and Hispanic students attending schools offering Cisco, Microsoft or Novell classes are less likely to enroll in one of these classes. The differences are largest at the high school level: about 1.5 percent of black students and 1.8 percent of Hispanic students in schools with certification classes enrolled in at least one Cisco, Microsoft or Novell class whereas 2.4 percent of white students participated. The two-year colleges that responded to the survey also indicated that minority participation in their certification classes was somewhat lower than that of whites students; 1.6 percent of black students and 2.3 percent of Hispanic students in the two-year colleges enrolled in a certification class compared with about 2.8 percent of white students.

The case study staff interviews suggest that several factors can reduce participation of minority students. Some staff members indicated that minority participation was held down by IT class prerequisites or a policy of discouraging students with low achievement levels. Language barriers were an important factor for some Hispanic students. Several case study teachers reported that students with limited language abilities sometimes found the IT terminology and online texts challenging.

The National IT School Staff Survey also indicates that females are substantially underrepresented in both high school and college IT certification classes. In the median high school, females represented only 10 percent of all students taking a Cisco, Microsoft or Novell class. In two-year colleges, the comparable figure was only 15 percent. Across all responding schools, female students made up 16 percent of IT certification class enrollment in high schools and 21 percent in the two-year colleges.

School staff members suggested that female students' social concerns, preferences and learning styles may contribute to their low rates of participation. According to staff members in the case study sites, some female students were reluctant to enroll in IT simply because they did not like the prospect of being one of the few females in the class. In addition, a few teachers reported that many female students consider the physical tasks related to some networking programs (for example, climbing a ladder to fix or install network cables) to be unappealing. Some instructors reported that male students tend to be less cautious than female students about what they say in IT class and that, as a result, they often dominate class discussions and projects; this behavior may make the class less fulfilling for some female students.

Some case study schools are seeking to increase the diversity of their classes. They are exposing more students to IT in earlier grades, advertising their IT programs in brochures and publications sent to parents, and cultivating minority and female student leaders who can

promote IT to other students. Schools that want to increase minority and female participation in IT programs may want to consider expanding these or other outreach efforts.

- **Both for-credit classes and non-credit classes in case study colleges tended to attract students with substantial work experience, but for-credit students were more likely to be changing careers whereas most non-credit students already were in the IT field.**

Differences in for-credit and non-credit college IT programs appear to influence the mix of students the programs attract. For-credit IT programs usually are designed to serve students interested in working toward a degree or, at least, toward a college certificate. Non-credit programs typically are designed to serve students who want to develop or upgrade their IT skills or prepare for industry certification tests. Although the case study students in the for-credit programs and the non-credit programs were similar in some respects (for example, both groups had substantial prior work experience), they differed in ways that reflect the designs of the two types of college programs.

Many of the for-credit case study students were changing careers whereas most of the students enrolled in non-credit programs already had substantial IT work experience. At the time of the IT survey, more than half (54 percent) of the non-credit students had four or more years of IT-related work experience compared with only 33 percent of the for-credit students. The non-credit students also had substantially higher levels of educational attainment; about 54 percent had a bachelor's degree compared with 28 percent of for-credit students.

A small but nontrivial portion of the students who take non-credit classes appear to be interested in earning a degree even though they are not earning any credit for their IT class. About 11 percent of the non-credit students reported that they had to earn a two- or four-year college degree to get the job they plan to obtain within the next 10 years.[4] According to case study staff members, some working students choose non-credit classes because the classes are accelerated and offer more convenient schedules than for-credit classes do. Other non-credit students simply did not want to have to fulfill other requirements associated with for-credit programs. Colleges might explore the feasibility of expanding for-credit classes with schedules and formats that are convenient for working students or waiving some requirements for students who have relevant work experience.

STUDENT OUTCOMES

Certification programs typically focus on several objectives. Most programs seek to help students prepare for IT certification exams. Recognizing that some students may not choose to obtain a certificate but still may pursue careers in IT, many programs seek to help interested students in other ways. Some try to prepare students for other IT-related education programs. Nearly all programs also seek to help students acquire skills needed in IT jobs.

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[4]Another 6 percent of non-credit students indicated that they needed an advanced degree, but most of these students already possessed a bachelor's degree.

Most of the analysis of student outcomes relies on data from the Case Study IT Student Survey. Figure 1 summarizes findings from this survey relating to students' certification, education and employment experiences after completing their IT class. In the analysis of outcomes, which is summarized here, we also made use of some data on certification rates from the National IT School Staff Survey.

- **Most students do not receive certification, but college students are more likely than high school students to do so.**

One of the original goals of certification classes is to help students prepare for and obtain IT certificates, but this outcome is not very common. Both the National IT Staff Survey and Case Study IT Student Survey suggest that only a small portion of the high school students who take Cisco, Microsoft or Novell classes earn one of the three companies' IT certificates. More than half (52 percent) of high schools responding to the National IT Staff Survey reported that none of the students in their IT classes obtained a Cisco, Microsoft or Novell certificate. The average certification rate for all high schools was about 23 percent. Only 12 percent of the participants in the case study high school classes reported that they earned one of the certificates for which their class was designed to prepare them.

FIGURE 1

OUTCOMES OF PARTICIPANTS IN CASE STUDY HIGH SCHOOL AND
TWO-YEAR COLLEGE IT CERTIFICATION CLASSES
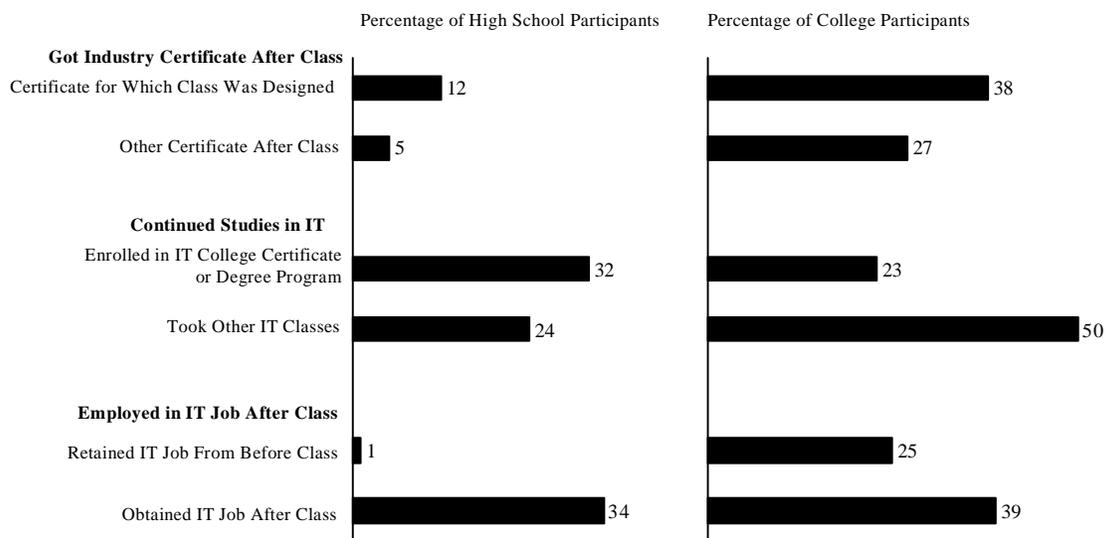
	Percentage of High School Participants	Percentage of College Participants
Got Industry Certificate After Class		
Certificate for Which Class Was Designed	12	38
Other Certificate After Class	5	27
Continued Studies in IT		
Enrolled in IT College Certificate or Degree Program	32	23
Took Other IT Classes	24	50
Employed in IT Job After Class		
Retained IT Job From Before Class	1	25
Obtained IT Job After Class	34	39

Source: Case Study IT Student Survey, 2002, Princeton, NJ: Mathematica Policy Research, Inc.

The proportion of two-year college students who obtain IT certificates is somewhat higher than the proportion of high school students who do so. The National IT School Staff Survey indicates that an average of 36 percent of students in for-credit college classes earned a Cisco, Microsoft or Novell certificate. Among the college students responding to the Case Study IT Student Survey, 38 percent secured one of the certificates for which their class was designed. One likely reason that colleges have higher certification rates than high schools do is that colleges offer more complete sequences of certification classes.

Low certification rates are likely to pose a dilemma for some schools in the future. Programs with low rates could choose to de-emphasize this objective. However, doing so could undercut the motivation of some students to take the class or to work hard at acquiring valuable IT skills. Alternatively, schools could continue to emphasize certification as a central goal. However, should certification rates remain low, this approach risks alienating key constituencies such as students, school administrators and employer partners. To ensure that expectations are realistic, program staff members could reduce the importance they place on certification but still retain it as one of many objectives.

- **Most case study students continued their IT studies after taking the certification class.**

Some IT certification classes seek to help students prepare for other IT education and training programs. Some classes are designed to help confirm students' interest in the IT field, help them develop skills that are useful in more advanced programs and provide credits that count toward another degree or college certificate.

In fact, most students in the case study programs continued their IT studies after completing the certification class. About 32 percent of those who had taken a high school certification class enrolled in an IT college certificate or degree program, and another 24 percent took some other type of IT class after leaving high school. An even larger portion of the participants in the case study community college classes continued their IT studies after the certification class; 23 percent reported entering another postsecondary IT program, and another 50 percent took some other type of IT classes. A substantial portion of these participants had jobs with employers who helped pay for their classes.

Many case study students believed that the certification class helped them prepare for other IT programs. About half of all respondents to the Case Study IT Student Survey reported that the class was very helpful in preparing for additional education or training. Nearly 40 percent of students reported that the class also was very helpful in clarifying their career goals, which may have helped them select an appropriate program. For about a quarter of the students who took a high school certification class, the class provided course credits that they used in a college program.

- **A substantial portion of students entered or stayed in IT jobs paying good wages.**

Ultimately, the goal of most IT certification classes is to help students pursue careers in the IT field. Indeed, a substantial portion of the case study student survey sample obtained or retained IT-related jobs after the class. About 35 percent of the students participating in high school classes reported that they were employed in an IT-related job after their certification class. Slightly less than two-thirds of college participants were employed in IT positions after the class; about 39 percent obtained these IT positions after the class started, and the remaining 25 percent retained an IT job that had begun before the class.

Most students who obtained IT-related positions found their jobs on their own, but school staff members provided assistance to some. About 21 percent of the high school students who reported obtaining an IT-related job after they left high school indicated that school staff members helped them "find or get" that job. A somewhat smaller percentage of the college students (13 percent) reported that school staff members helped them find or get their jobs.

On average, case study students' IT-related jobs paid good wages. High school participants who obtained IT-related jobs received an average hourly wage of $11.47, an amount substantially higher than the average amount for workers of a similar age nationally. Community college students who obtained or stayed in IT-related jobs also made good wages, averaging $19.29 per hour; this amount is roughly comparable with other national estimates of average wages for similar IT jobs.

The average hourly wages received by students with an IT certificate was somewhat larger than that of students without a certificate. Overall, among the community college participants employed in IT jobs, the difference in the average hourly wages of students with a certificate and students without a certificate was $3.88. Even after controlling for students' work experience, education and other qualifications, the wage differential associated with a certificate remained about the same. However, these results should be interpreted with caution because the survey did not measure all of the qualifications that may affect wages.

Female participants were less likely than their male peers to secure IT jobs, and they received lower wages when they did obtain one of those jobs. Only about 55 percent of the female participants in college IT classes reported that they were employed in IT compared with 68 percent of the male participants. Women who obtained IT-related jobs had lower average hourly wages ($15.89) than did men ($20.61). Much of this gender gap in average wages appears to be explained by the fact that female participants had somewhat less IT work experience and were less likely to obtain certificates. If females observe this wage gap in conjunction with lower female rates of participation in IT classes and lower rates of female employment in IT among those who do participate in IT classes, it may further discourage them from entering the field.

Overall, the IT certification case study programs appear to have promising outcomes. A substantial portion of participants appear to be pursuing their studies in IT and securing IT-related jobs. However, it is not clear how students' certification classes have affected their outcomes; some students might have pursued a similar path even if they had not taken the class. Additional research would be necessary to estimate the effects of the classes on students' careers.

- **Programs need better follow-up information to support continuous improvement.**

Information on students' outcomes in career-focused programs can be helpful to the program staff. Programs can benefit by obtaining updated information on the range of career paths that students pursue so they can help future students identify career options as well as the skills and credentials needed in particular kinds of jobs or programs. In addition, school staff members must have information on student outcomes to gauge the extent to which programs appear to be achieving specific program objectives. Information on average student outcomes may help identify promising program models.

Many case study schools had incomplete information on student outcomes because they had difficulty staying in touch with students. Many instructors were familiar with the outcomes of some of their students, but they lacked the resources to collect information systematically on all of them. Only half the case study schools reported that school staff members regularly conducted surveys to track the outcomes of students who had completed the program.

The potential value of tracking those obtaining certification is suggested by the fact that many students earned industry certificates without obtaining any institutional degree or other credential. About 55 percent of the case study college students earned some type of credential—a degree, college certificate or industry certificate. Nearly half of this group received only an industry IT certificate and no degree or college certificate. Thus, schools and states that are unable to identify students who earn industry certificates may substantially underestimate the number earning some type of credential.

IT companies might explore ways to help schools track and improve outcomes. For example, schools could ask all students entering their IT programs to sign a release allowing IT companies to divulge information on whether they pass certification exams, and to share any other information collected in company surveys relating to students' employment or educational achievement. Student releases also could enable schools and certification companies to share information on the students' telephone numbers and e-mail addresses, thus increasing the likelihood of a high response rate on follow-up surveys. Schools might offer to pay for certification tests for students who sign these releases, increasing the incentives for both students and certification companies to agree to this type of follow-up effort.

The future of certification programs and other vocational programs depends in part on better documentation of how these programs contribute to students' success in careers. Many policy-makers continue to ask for convincing evidence of the value of occupationally focused programs, particularly in high schools. Efforts to improve programs and identify promising practices are contingent on a better understanding of students' outcomes. By working more closely with certification companies and other partners, schools can learn more about students' program and postprogram experiences, and use that information to help more students succeed in their chosen careers.

I. INTRODUCTION

Many high school and two-year college vocational programs are exploring new ways to help students develop and document skills that are valued in the labor market. Over the past decade, some federal, state and local efforts to improve vocational programs have focused on reorganizing curricula around skill standards and assessments that employers have formulated. One noteworthy recent example of this trend is the large numbers of schools that have adopted Information Technology certification programs based on the curricula and certificates developed by companies such as Cisco, Microsoft and Novell as well as by organizations supported by IT industry associations such as Comptia. Some educators have suggested that IT certification programs are attractive because they provide opportunities to earn certificates that are recognized in the labor market to a variety of students, including students who have no plans to attend college and have not been successful academically (Murnane, Sharkey and Levy 2002). If IT certification programs are successful in this regards, they might serve as models for other efforts to develop nationally recognized credentials for jobs that do not require a four-year college degree.

Because no rigorous evaluations of IT certification programs have been conducted, educators have many questions about them. In particular, questions exist about the mix of students who participate, the breadth and value of the skills that programs are designed to develop, the costs of implementing them, and the extent to which they actually help students achieve their career goals. As policy-makers and educators consider ways to improve the Perkins legislation that supports vocational programs, they may benefit from examining the role of these new kinds of IT programs and the issues they pose for educators.

To begin to address some of these issues, the U.S. Department of Education contracted with Mathematica Policy Research, Inc. (MPR) to conduct an exploratory IT Certification Study of Cisco, Microsoft and Novell programs in high school and two-year colleges. The main objective was to describe the design of these programs, the mix of students who participate and students' outcomes. The study was not designed to measure program effects—that is, the extent to which these programs affected outcomes. The three main data sources for the study are a national survey of staff members in a representative sample of high schools and two-year colleges offering IT certification classes, a survey of students who completed IT certification programs in 20 case study schools, and extended interviews with staff members and other partners in these case study sites. Chapters II, III and IV of this report are organized around an analysis of three main topics: (1) the design and range of costs of certification programs (chapter II), (2) the number and mix of students who have access to and participate in programs (chapter III), and (3) students' outcomes (chapter IV). The rest of this introductory chapter provides some information on (1) IT certification and some related policy issues and (2) the study's main research questions and data sources.

A. BACKGROUND: IT CERTIFICATION AND POLICY CONTEXT

Many computer hardware and software companies have created new credentials for people interested in demonstrating their qualifications for jobs in information technology. To secure one of these credentials—or IT certificates—one must pass a test administered by a third-party vendor. Although most items on these tests are multiple choice, others are open ended or require the completion of a specific task or simulated task (typically on a computer). The IT companies that create the new credentials typically develop not only the certification tests but also the study guides or program curricula that are designed to help people prepare for them.

IT certification is a fairly recent phenomenon. During the late 1980s, Novell introduced the Certified Novell Administrator (CNA) certification, which was designed primarily for people interested in network administrator jobs that involve installing and monitoring networks running Novell software. Cisco and Microsoft introduced their first certificates during the 1990s. Like Novell's certificate, those of Cisco and Microsoft were designed for tasks related to network administration (see Table I.1). Cisco certificates focus on the design and installation of network hardware (and particularly hardware sold by Cisco) whereas Microsoft's and Novell's certificates focus on the operating systems and other software that run networks. Subsequently, the three companies introduced additional certificates that focus on other IT roles, and many other computer hardware and software companies developed their own certifications.[5] Although each company's certification tests tend to focus on the company's own products, the tests often cover a substantial amount of additional material relevant for the occupation to which the certification pertains.

Although information is limited on the number of people who have passed IT certification tests and have received certificates, the estimates available suggest that these credentials are becoming fairly common. In 2000, one analyst estimated that about 2.5 million IT certificates had been issued to about 1.6 million people (Adelman 2000). At that point, the most common certificates were those issued by Microsoft and Novell.[6] Comptia, an industry association, had also issued many of its A+ certificates, designed primarily for entry-level IT jobs such as help desk and technical support positions.

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[5]The number of IT companies offering certification continues to expand. Some of the large ones are Adobe, Apple, Compaq, Hewlett Packard, IBM, Oracle, SAS and Sun.

[6]Adelman reported that, by June 2000, Microsoft had issued 1,043,000 certificates, and by late 1999, Novell had issued 563,000. Adelman also estimated that Cisco had issued 35,000 certificates by December 1999.

TABLE I.1

SELECTED CISCO, MICROSOFT AND NOVELL CERTIFICATES AND
RELATED JOBS AND TASKS

Certificate	Number of Tests to Earn Certificate	Jobs for Which Certificate Is Designed	Illustrative Skills and Tasks
Cisco			
Cisco Certified Network Associate (CCNA)	1	Helpdesk Engineer, Field Technician, Assistant Network Administrator	Install network hardware such as switches and routers
Cisco Certified Network Professional (CCNP)	4	Network Administrator, Network Technician	Build and troubleshoot networks
Cisco Certified Design Professional (CCDP)	4	Network Design Engineer	Design local and wide area networks
Microsoft			
Microsoft Certified Professional (MCP)	1	Diverse entry-level positions, including help desk technician, assistant network administrator and programmer	Various
Microsoft Certified Systems Administrator (MCSA) on Windows 2000	5	Network Administrator	Maintain servers and PCs in networks
Microsoft Certified Systems Engineer (MCSE) on Windows 2000	7	Network/Systems Engineer	Install, configure and troubleshoot networks
Microsoft Certified Database Administrator (MCDA) on SQL Server 2000	4	Database administrator or developer	Design, develop and manage databases
Microsoft Certified Solution Developer (MCSD) for .NET	5	Software engineer	Develop desktop and Web-based software applications
Novell			
Certified Novell Administrator (CNA)	1	Network Administrator or Assistant Network Administrator	Install and monitor networks
Certified Novell Engineer (CNE)	5	Network Design	Plan, configure and install networks

No systematic data exist on the annual rate at which IT certificates have been issued since 2000, but Cisco and Microsoft have reported estimates suggesting that large numbers of people continue to secure their companies' certificates even as the IT job growth has slowed. In January 2003, Microsoft reported that it had issued a total of about 1.4 million certificates that have not yet been retired—which suggests that the number of nonretired Microsoft certificates issued grew by about 400,000 during the two-and-a-half-year period following June 2000.[7] Cisco representatives indicated that, by January 2003, the company had issued more than 450,000 certificates worldwide. This figure, in conjunction with Adelman's estimate of approximately 35,000 Cisco certificates issued by the end of 1999, suggests that Cisco issued more than 415,000 certificates during the three years after December 1999.[8]

Most people preparing for certification tests appear to rely on either self-study guides and tutorials or short classes offered by private proprietary schools and other businesses. A survey conducted by Prometric, one of the largest firms administering IT certificates, suggests that most of those who succeed in securing a certificate had either studied independently, using a book or online material, or attended one of the short, intensive, for-profit "boot camp" classes offered by various proprietary schools and other businesses (Prometric 2001). Only about 6 percent of this group reported that their preparation for the exam included taking a two- or four-year college certification class. The Prometric study did not indicate the percentage taking a high school certification class, perhaps because too few respondents mentioned this option as a source of training.

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[7] These estimates do not include the old certificates that Microsoft issued for products it no longer supports, for example, the Microsoft Certified System Engineer certificates for NT 4.0. Nor do they include any of the Microsoft Office Specialist certificates designed for those using Word, Excel or other office applications.

Although certification programs in high schools and colleges represent only a portion of the certification training market and sometimes compete with proprietary schools, they have become fairly pervasive. As of the 2000–2001 school year, approximately one of seven high schools in the United States and one of four two-year colleges offered at least one class designed to prepare students for a Cisco, Microsoft or Novell certification exam.[9] The rapid spread of these programs is notable since the programs and the types of credentials they are designed to help students obtain did not exist 15 years ago.

To foster the development of certification training programs, IT companies have developed curricula designed to prepare students for their own certification exams. Some companies such as Cisco and Microsoft have developed two sets of curricula—one set designed for short proprietary school classes and another set designed for longer high school and college classes. Some companies such as Cisco have also developed end-of-semester, online tests for high school and college courses. Students must take and pass these tests to go on to the next semester. However, these tests are distinct from and somewhat broader than the certification tests.

This report focuses on Cisco, Microsoft and Novell programs at high school and two-year colleges. Although educators are interested in all the ways students prepare for certification exams, they have particular interest in high school and two-year college programs because these programs are growing rapidly and receive some public funding, including federal Perkins funds.

(continued)
[8]We were unable to obtain an updated estimate of the number of Novell certificates issued.

[9]These estimates are based on the lists that Cisco, Microsoft and Novell provided of the schools offering one of their classes by spring of 2001. The total count of high schools is from the Common Core database for school year 1999–2000, and the total count of colleges is from the Integrated Postsecondary Educational Database (IPEDS) for school year 1998–1999. See chapter III for additional information on the prevalence of schools that offer these certification classes.

Because the programs are publicly subsidized, some educators and policy-makers are interested in the ways in which they could be benefiting students.

Some IT certification advocates have suggested that these programs are useful because they can help students secure valuable IT credentials and good jobs. IT certificates are designed for a wide variety of jobs, including network administration, technical support, database development and software development (see Table I.1). Although IT job growth has slowed since the 1990s, labor market projections for 2010 indicate a large increase in the number of jobs in several computer-related occupations—including several of the fields for which IT certificates are designed, for example, network administrators, database administrators and computer support specialists (Bureau of Labor Statistics 2002).

Although average salaries of many IT occupations have dropped somewhat since 2000, many IT jobs still pay attractive salaries. According to IT vendors and online certification magazines, earning an IT certificate is a good way to compete for these jobs. Online salary surveys indicate that people who secured IT certificates earned salaries ranging from about $35,000 to $60,000 in 2002, depending on the specific certificate (*Certification Magazine* 2002; *Microsoft Certified Professional Magazine* 2002; and *TCPmag.com* 2002).[10] However, the validity of this and similar surveys is hard to assess because the online magazines typically do not report response rates. Moreover, few studies include rigorous statistical analyses designed to isolate the specific value of a certificate as distinguished from the other credentials and assets

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[10]For example, based on its 2002 Salary Survey, *Certification Magazine* reported salaries of people who had various types of certificates and who responded to the magazine's online survey. The salaries ranged from about $37,000 for employees holding Comptia's A+ certificate or Prosoft's CIW certificate to about $60,000 for those holding Oracle's OCP certificate. Both *Microsoft Certified Professional Magazine* and *TCPmag.com* (which pertains to Cisco programs and certifications) report fairly high salary ranges in their 2002 surveys. These and other certification salary surveys can be found at www.certcities.com/editorial/salary_surveys.

that employees possess. The simple descriptive data that do exist suggest that a large percentage of those who secure high-paying jobs have at least a bachelor's degree and that most have substantial IT work experience.[11] Thus, one cannot easily distinguish the value of the certificate from that of the other qualifications possessed by certificate holders.

The advent of IT programs is potentially important not only because they may help some people secure good jobs but also because they may illustrate four broader workforce development issues. These issues are described in the following subsections.

Concern about those without college degrees. Earning a college degree has become a nearly universal goal and for good reason. The earnings of two- and four-year college graduates far exceed those of workers who possess only a high school degree. Although the vast majority of young adults hope to earn a bachelor's degree someday, most do not achieve this goal. Broad public support exists for programs such as Upward Bound and Pell Grants, which are designed to help more people enroll in college. At the same time, some educators and policy-makers continue to be interested in ways to help people secure other kinds of postsecondary education and other credentials valued in the labor market. Some researchers such as Murnane, Sharkey and Levy (2002) suggest that high school and postsecondary certification programs may provide a pathway to good jobs for those who have difficulty securing a four-year college degree.

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[11]For example, *Microsoft Certified Professional Magazine*'s 2002 survey indicated that about 54 percent of those who responded to the online surveys and hold a Microsoft certification (principally the MCP, MCSA or MCSE certificates) possess at least a bachelor's degree (*Microsoft Certified Professional Magazine* 2002). Those with higher levels of educational achievement earned somewhat higher salaries. For example, those with a bachelor's degree earned an average of $64,000 annually compared with $53,000 for those with just a high school degree. The differences in salary by levels of work experience are even greater: an average of only $39,000 for those with one year of work experience compared with more than $75,000 for those with 15 or more years of experience. The survey does not report salaries for those with both low levels of educational achievement and limited work experience.

Interest in helping adults upgrade skills or change careers. Many adults, including those with and those without a college degree, discover that they need to develop new skills to secure a promotion, obtain a better job in the same field or change careers. Many public workforce programs—including the Individual Training Account vouchers supported by the federal Workforce Investment Act—are designed to assist adults in these efforts. Although many county workforce boards allow clients to use training subsidies for IT certification programs, these programs are often comparatively expensive, which has heightened interest in whether they are successful in increasing participants' earnings.

Interest in new strategies for developing and promoting industry-based skill standards. Some policy-makers and educators, particularly those interested in strengthening vocational programs, have supported efforts to develop industry-based skill standards and assessments. In the late 1980s, American auto manufacturers succeeded in upgrading automotive repair programs by supporting the development of the Automotive Service Excellence (ASE) curriculum and the ASE credential. The 1994 National Skills Standards Act funded a number of other industry-based skill standards initiatives. Although some of these initiatives have had some effect on vocational curricula, most do not appear to have been embraced by either employers or schools. The emergence of IT certification is noteworthy, in part, because large numbers of schools have adopted programs designed to prepare students for these new credentials and because some employers recognize and value the new credentials. Although the success in promoting IT certificates may partly reflect economic conditions in the IT sector, the strategies used may teach lessons about the development of other industry-based standards.

Efforts to enhance and update education accountability systems. Policy-makers and educators have been seeking to improve vocational accountability systems to provide a clearer basis for evaluating programs and to identify needed program improvements. Currently, Perkins

and other federal programs call for reporting the portion of participants who earn educational credentials. For purposes of performance measurement, schools and public agencies typically report only credentials issued by educational institutions, in part, because certificates issued by firms and industry groups are more difficult to track. However, the growth of industry certificates may call for enhancements or modifications to existing accountability systems.

B. STUDY RESEARCH QUESTIONS AND DATA SOURCES

The U.S. Department of Education contracted with MPR to conduct the IT Skill Certification Study, an exploratory examination of vendor-specific programs in high schools and two-year colleges. The study focuses on Cisco, Microsoft and Novell certification programs, which were among the most common high school and college certification programs when the study was initiated in late 2000.[12]

The study and this report are organized around three main sets of research questions:

1. ***Program Design and Costs.*** What is the design of IT certification programs, and what resources are needed to develop them? (chapter II)

2. ***Student Participation.*** Which segments of the student population have access to IT programs, which students participate, and how do participation patterns reflect school recruitment and screening strategies? (chapter III)

3. ***Student Outcomes.*** What are students' outcomes, how do schools seek to help students enter IT jobs and postsecondary programs, and how do schools track students? (chapter IV)

The study draws on four main data sources: (1) lists provided by Cisco, Microsoft, and Novell identifying the high schools and colleges that offer a class preparing students for the certification exam of one of the three companies; (2) a national survey of school staff members

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[12]During the past two years, many schools have introduced many other types of IT certification programs, including other vendor-specific certification programs (such as those of Oracle) and "vendor-neutral" certification programs (such as Comptia's A+ program).

in a random sample of these schools; (3) a survey of students completing programs in 20 case study schools that offer one of the three types of these classes; and (4) site visits with school staff members, students and other partners in half the case study schools as well as telephone interviews with staff members in most of the others. Although the findings from the National IT School Staff Survey are representative of all high schools and two-year colleges with Cisco, Microsoft and Novell programs, the findings from the case study sites pertain only to those sites. Next we provide additional information about each of the four data sources.

Lists of Cisco, Microsoft and Novell programs. In summer 2001, each of the three vendors provided lists of the high schools and colleges that were offering a class designed to prepare students for one of their certification tests. Most of these schools offered at least one certification class during the 2000–2001 school year. To obtain additional information about the schools on these lists, MPR matched them against public data sources containing information on schools' total student enrollment, ethnic and racial composition of the student body, locality, and region of the schools. The data source for high schools was the Common Core Database for school year 1999–2000 and, for colleges, the Integrated Postsecondary Educational Database (IPEDS) for school year 1998–1999.

National IT School Staff Survey. In spring 2002, MPR conducted a survey of school staff members in a nationally representative random sample of the schools on the Cisco, Microsoft and Novell lists. The high school and college samples each contained seven strata defined by whether a school offered Cisco, Microsoft or Novell classes.[13] The survey included questions on

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[13]The seven strata were (1) Cisco Only; (2) Microsoft Only; (3) Novell Only; (4) Cisco and Microsoft; (5) Cisco and Novell; (6) Microsoft and Novell; and (7) Cisco, Microsoft and Novell. The sample was designed to increase the precision of estimates for each type of class. However, because the response rates from certain strata were lower than anticipated, the precision for some strata was not high enough to report findings by type of class for many survey items.

the size and type of school; the students enrolled in the school; the students enrolled in Cisco, Microsoft and Novell certification classes; the types of certifications for which these classes prepare students; the percentage of students completing IT classes and passing certification exams; and factors that helped or impeded the development of the IT certification programs.

MPR sent the survey to the school contact on the Cisco, Microsoft and Novell lists. The contact person's position varied and included district staff members, school principal, department chair and IT instructor. Schools were encouraged to involve whichever staff members could best respond to the questions. Most schools completed the survey on the Internet, and MPR sent a hard-copy questionnaire to all those who did not respond. In addition, survey interviewers called most nonrespondents, and a few chose to be interviewed by telephone. MPR obtained responses from 262 colleges and 266 high schools for an overall response rate of 71 percent.

Case Study IT Student Survey. In spring 2002, MPR conducted a survey of people who had participated in a Cisco, Microsoft or Novell class in 10 case study high schools and 10 case study two-year colleges serving the same areas as the high schools.[14] The case study sites were selected purposefully so the sampled schools covered most regions of the country and served a diverse mix of students.[15] The case study high schools include four vocational high schools and

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[14]The student survey sample members in Cisco classes were in high school and two-year college Cisco Academies designed to prepare students for the Cisco Certified Network Associate (CCNA). The Microsoft survey sample members were in classes designed to prepare students for the Microsoft Certified Professional (MCP) and Microsoft Certified System Engineer (MCSE) exams. The Novell sample members were in classes designed for the CNA exam.

[15]In particular, the high schools were selected to ensure that at least half the schools served a substantial number of black and Hispanic students or students eligible for free or reduced-price lunch.

six comprehensive high schools. Most of the community colleges offer both for-credit and non-credit IT classes. Table I.2 contains a list of the case study schools.

So the follow-up period would be long enough to permit observation of postsecondary employment and education outcomes in the 2002 student survey, the high school student sample consists of all the Class-of-2000 students in the case study schools who had taken at least one Cisco, Microsoft or Novell certification classes during the 12th grade. The community college students were randomly selected from among those enrolled in one of the "last-in-sequence" Cisco, Microsoft or Novell courses in school year 1999–2000. The community college student sample includes separate strata for students enrolled in for-credit and non-credit IT certification classes.[16] Because all the sampled college students had reached the last class in the sequence of certification classes, they may have been somewhat more committed to IT than the average student taking a single IT certification classes.[17]

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[16]The analysis of the college survey uses sampling weights that reflect the total number of students enrolled in the end-of-sequence classes in each school. Because the for-credit students represented about two-thirds of the students taking Cisco, Microsoft and Novell classes, these students were assigned the same percentage of the total weight. The analysis of the high school survey does not use weights because the survey sample includes all the Class-of-2000 students in case study schools who took a certification class in their senior year.

[17]For example, college students who started but did not complete the certification course sequence may have been somewhat less interested in IT or may have had more difficulty with the curriculum. It is also possible that the high school sample, which consists entirely of students taking certification classes in the 12th grade, is not representative of the population of students who take a certification class in 11th but not 12th grade.

TABLE I.2

HIGH SCHOOLS AND COMMUNITY COLLEGES INCLUDED IN IT CERTIFICATION
CASE STUDIES: PARTICIPATION IN STUDENT SURVEY, SITE VISITS
AND PHONE INTERVIEWS WITH STAFF MEMBERS

School	Location	Type of IT Classes	School's Participation in Data Collection		
			Student Survey	Site Visits	Staff Phone Interviews
High Schools					
Philadelphia Schools[a]	Philadelphia, Penn.	Cisco	X	X	
South Kitsap	Port Orchard, Wash.	Microsoft, Novell	X	X	
Whiteside Vocational Center	Sterling, Ill.	Cisco, Microsoft	X	X	
West Jones	Laurel, Mo.	Cisco	X	X	
Garinger	Charlotte, N.C.	Microsoft	X	X	
Cuyahoga Valley Career Center	Brecksville, Ohio	Novell	X		X
Sheldon	Houston, Tex.	Cisco	X		X
Norfolk Technical Vocational Center	Norfolk, Va.	Novell	X		X
Folsom	Folsom, Calif.	Cisco, Microsoft	X		X
Boulder Technical Education Center	Boulder, Colo.	Cisco	X		
Community Colleges					
Montgomery	Blue Bell, Penn.	Cisco, Novell	X	X	
Bellevue	Bellevue, Wash.	Cisco, Microsoft	X	X	
Black Hawk	Moline, Ill.	Cisco, Microsoft	X	X	
Jones County	Ellisville, Mo.	Cisco, Novell	X	X	
Central Piedmont	Charlotte, N.C.	Microsoft, Novell	X	X	
Cuyahoga	Cleveland, Ohio	Cisco, Microsoft	X		X
Tomball	Tomball, Tex.	Cisco, Microsoft	X		X
Tidewater	Virginia Beach, Va.	Cisco, Microsoft, Novell	X		X
Solano	Suisun, Calif.	Cisco, Microsoft	X		
Red Rocks	Lakewood, Colo.	Cisco	X		X

[a]Three Philadelphia schools participated in the student survey: John Bartram, Overbrook and Girls High Schools. Two Philadelphia schools participated in the site visits: Mastbuam and University City High Schools.

The survey, which was conducted by telephone, includes questions on students' background, career goals, assessment of their IT class, education, employment and wages. Several questions were designed to gauge the extent to which their subsequent educational and employment experiences remained focused on the IT sector. The Case Study IT Student Survey yielded responses from 96 students who took a high school certification class, 114 students who took a for-credit college class and 97 students who took a non-credit college class. This survey achieved a response rate of 71 percent.

Case study site visits and staff interviews. To collect additional information about the 20 case study programs attended by the students participating in the IT Student Survey, researchers visited half of these schools and interviewed staff members in nearly all the others. These visits and interviews were conducted during 2002. Researchers conducted site visits to the five case study high schools and five colleges listed in the top panel of Table I.2. The same researchers interviewed by telephone selected staff members in 8 of the 10 other case study schools. (Administrators in two case study schools chose not to participate in the telephone interviews.) During each site visit, researchers interviewed at least one school administrator, one IT instructor, several students, and one employer partner providing internships to students or other forms of support to the program. Researchers also observed at least one certification class in each site. During the site visits and telephone interviews, researchers collected information on the design and cost of the school's IT programs; the instructional strategies instructors used; the way students were recruited and screened; the school's internship and job placement programs; and the perceived strengths and weaknesses of the certification programs from the perspective of school staff members, students and employers.

II. DESIGN OF IT CERTIFICATION PROGRAMS

The design of a school's IT certification program reflects local priorities and constraints. Although vendors define some of the basic features of the program, schools have discretion about which specific skills their courses cover and how instructors teach the material. In some cases, programs may place the greatest priority on preparing for the certification test whereas, in other cases, the program may emphasize a broader set of IT-related skills. A program's design can reflect the pedagogical objectives of the instructor, school or state. The way schools balance competing priorities can have important consequences for the types of students who are likely to

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KEY FINDINGS

- *High school certification programs have to compete for students' time with schools' other academic priorities.* Because of academic graduation requirements, the time available for IT certification classes can be limited, and some high school programs may not cover all the skills required for certification. However, links with community colleges can help students complete certification classes after high school.

- *For-credit and non-credit college case study programs often operate independently and are designed to serve different needs, but some colleges see opportunities to coordinate these programs better.* For-credit college certification classes are designed to lead to degrees whereas non-credit classes seek to respond quickly to new skill needs of industry and students. Some colleges are seeking to coordinate these IT classes better by sharing equipment and giving more students opportunities to earn credit.

- *IT certification program staff and students see a need for more hands-on activities and internship opportunities.* Limits on class time and instructor planning time as well as difficulty coordinating with employers sometimes limit the amount or quality of hands-on activities. To expand opportunities for students to apply skills, some programs have developed student clubs and competitions as well as partnerships with temporary agencies and non-profit organizations that offer internships.

- *Computer equipment and teacher training can be substantial investments for IT certification programs.* Computer equipment needs are often significant but can be supported by using schools' existing equipment or accessing special funding. Teacher training needs can be extensive because schools often assign teachers from other disciplines and because certification requirements change rapidly.

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benefit from the program and how they are likely to benefit. This chapter's main findings are summarized in the box on the previous page

Schools interested in developing IT certification programs need to be prepared not only to shape the learning priorities of the IT classes but also to meet these programs' resource needs. Schools may need to invest in computers, cabling equipment, software, textbooks and teacher training. The costs of certification programs depend on a school's existing assets, including its computer hardware and the skills of its staff. Although the case study sites were unable to provide comprehensive cost data, they did share information on their largest program costs and major funding sources.

This chapter examines the design and some of the main costs of IT certification programs. The analysis draws on the staff interviews in the case study schools and the national survey of high schools and colleges. The rest of this chapter is organized around an analysis of factors that can influence (1) schools' IT program design choices, and (2) programs' resource needs.

A. DESIGN OF IT PROGRAMS

Schools appear to have common objectives when they introduce IT certification programs. Most of the case study schools said they were interested in helping students prepare for IT jobs. School staff members noted that participating students could benefit by obtaining relevant technical skills and one or more IT certificates valued by employers. High school program staff members suggested that these skills and credentials could help students get good jobs after they graduated, whether or not they chose to attend college. Similarly, staff members in community college IT programs viewed IT certificates as useful credentials even for those who sought to secure a two- or four-year degree.

Although case study schools appeared to have similar reasons for introducing IT programs, the specific design of their programs tended to reflect local educational priorities and constraints.

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Schools must make two types of design decisions that affect the learning opportunities available to students. First, they must determine the range of skills and knowledge to be covered by the IT classes, particularly, whether the classes cover all skills needed to prepare for a specific certification test or a subset of those skills. Second, instructors need to select or develop instructional strategies that can help students master the material, which can combine reading of texts, use of interactive software and various hands-on instructional approaches.

In this section, we examine some of the factors that can affect the design of schools' IT certification programs.[18] Because secondary and postsecondary schools have different priorities and structures, some of the key findings differ by type of school. Drawing on both the national IT school survey and the case studies, we present findings that pertain to three key issues: (1) how high schools respond to the competing priorities embodied in IT certification requirements, broader state IT competency frameworks and academic standards; (2) the efforts and capacity of community colleges to design a menu of IT classes that can accommodate diverse student interests and needs; and (3) programs' instructional strategies, including the use of interactive software and various hands-on activities.

- *High school programs have difficulty covering all certification skills.*

High schools' academic priorities sometimes reduce the time available to cover all certification requirements. Like other vocational programs, IT certification programs in high schools must respond to diverse educational priorities. Although most programs seek to help students acquire at least some of the technical skills covered in IT certification tests, they must also be configured to allow students to achieve other objectives. States and school districts

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[18]The way programs recruit and screen students is discussed in chapter III.

sometimes seek to expand participating students' IT career options by encouraging them to explore alternative IT careers, master basic IT skills that are not covered on certification tests, and develop problem-solving skills. Schools must also limit the intensity and duration of IT programs so students have enough time to spend on other subjects. As states have increased academic graduation requirements, the time the average student needs to spend on academics has grown, which has limited—and, in some states, reduced—the time available for vocational classes and other activities (Silverberg et al. 2002).

To prepare fully for certification tests, students have to master many technical skills, and this effort often requires a substantial amount of time. Complete high school Cisco programs for the Certified Cisco Networking Associate (CCNA) typically are covered in two full years of class work involving four 70-hour blocks of instruction. Vocational high schools are sometimes able to cover this complete sequence in one year or a year and a half; however, among the case study vocational schools, these faster-paced classes involved several hours each day in the classroom.[19] Students are not allowed to go on to the next semester until they have passed a test that is graded online by Cisco.[20] High school programs designed to prepare students for Microsoft networking certificates vary in length, but most range from one to two years. The length of programs depends largely on the number of Microsoft certification exams for which they are designed to prepare students.[21] Most Novell programs last one year and cover the material needed to prepare students for the Certified Novell Administrator (CNA) certification.

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[19]Colleges usually offer intensive programs that can be completed in a year or less.

[20]Although these Academy course tests are distinct from the Cisco certification exams, the course tests for the first two years of Academy courses include most of the skills and knowledge needed to pass the Cisco Certified Networking Associate (CCNA) certification exam.

[21]Microsoft's most basic certification, the Microsoft Certified Professional (MCP), can be obtained after passing one certification exam, which can be prepared for in one IT certification

Because the "model" high school program is often time-consuming, some high school IT certification programs, in practice, do not emphasize student mastery of all this material. The time students spend focusing on the skills covered in certification curricula can be affected by a variety factors, including the number and types of prerequisites students must fulfill before they take certification classes, whether schools offer a complete sequence of certification classes and schools' academic requirements.

Nationally, about two-thirds of all high school IT programs require students to complete other specific classes before they can take a Cisco, Microsoft or Novell class, which reduces the amount of the time they have left in high school after they complete the required classes. The most common prerequisites are math classes (required by 39 percent of programs), followed by some type of IT class (33 percent).[22] Although these prerequisites are designed partly to ensure that students have skills needed to do well in the class, they are also designed to achieve other goals. The math prerequisites also serve to ensure that students are making good progress academically. Required introductory IT classes are often designed to provide students with basic familiarity with hardware and software systems before they take more advanced or specialized classes.

State IT vocational standards can require that schools offer introductory classes or broaden the certification class curriculum, which further reduces the time available to focus on the skills

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(continued)
class. Other common Microsoft certifications include the Microsoft Certified Systems Administrator (MCSA) and the Microsoft Certified Systems Engineer (MCSE), which can be obtained after passing five and seven certification exams, respectively. These certifications require several classes of preparation to pass all exams.

[22]Most (78 percent) of the two-year college programs also have some type of prerequisite. However, in contrast to the high schools, where math classes were the most common prerequisite, the most common in colleges were other IT classes.

required by the IT certification tests. State IT standards sometimes emphasize introductory or broader IT material designed to develop a solid basic skills foundation for many alternative IT careers. For example, the state of Ohio has defined a list of competencies through its statewide IT initiative, IT Works Ohio. The list of skills and knowledge the state expects IT classes to cover includes some topics not emphasized in many vendor-specific IT certification exams, including project management, technical documentation, communications and customer relations.

Because of competing vocational and academic priorities, some high schools choose not to offer the complete sequence of classes needed to prepare for a certification. The National IT School Survey results indicate that more than a third of high schools with Cisco and Microsoft programs and 16 percent with Novell programs do not offer all the classes needed to prepare for any certificate. In these schools, participants would have to complete their preparation for a certification outside high school or after they graduate.

Even when schools do offer the complete sequence of classes, they sometimes have difficulty filling the higher-level courses, in part, because many upperclassmen need to focus on fulfilling state and local academic requirements. For example, in the case study high schools that offer the full sequence of Cisco classes, most students did not reach the higher-level classes. Because they had to complete many academic classes before they graduated, some seniors who took Cisco as juniors did not have room in their schedule to take the second year. Consequently, because few students took the higher-level classes, some case study schools grouped higher and lower students together in the same class and expected the more advanced students to work more independently.

Links with community college programs can help students complete certification classes. For students who cannot complete IT certification by the end of their senior year, efforts to link

high school and community college IT certification programs can allow students to continue their preparation for certifications after they graduate. Nationally, most high schools (63 percent) with certification programs have "articulation agreements" with at least one local college, allowing students to earn some college credit for the certification classes they take during high school. Articulation agreements appear to be somewhat more common among vocational high schools—three quarters of which reported having some agreement.[23] In addition, most community colleges with IT certification programs (64 percent accept credits from some local high schools for certification classes.

The structure of IT certification programs, and particularly Cisco programs, may help foster the development of articulation agreements. Selected state-level vocational staff members in the case study sites suggested that, because the certification curriculum was standardized and driven by established certification exams, articulation of IT certification courses was more straightforward than that of most other technical classes. The Cisco curriculum in high schools and colleges is particularly standardized because all schools must use the same online Cisco materials and end-of-semester exams, which are graded automatically by Cisco. In addition, Cisco's Regional Academies, which provide training and technical assistance to staff members in Cisco Local Academies, sometimes assist in the development of articulation agreements.[24] Because many Cisco Regional Academies are community colleges and most Cisco Local

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[23]This percentage may reflect the fact that vocational schools are more likely than comprehensive high schools to be members of tech-prep consortia, which are the federally funded, local institutional partnerships responsible for forging these type of agreements. However, the difference between the percentage of vocational schools with articulation agreements and the percentage of other high schools with these agreements is not statistically significantly at the 10 percent level.

Academies are high schools, the Cisco Academy structure often allows schools to forge or strengthen articulation agreements.

However, some IT articulation agreements remain limited in scope in ways that may inhibit their use. For example, some of the agreements give high school students college credits in only one local college that participates in a local tech-prep consortium or Cisco Regional Academy. Case study school staff members indicated that some college-bound students taking the class were not particularly interested in attending the college that accepted the certification credits. In some cases, these credits could be transferred from the college participating in the articulation agreement to other colleges, but even in these cases, logistical hurdles limited students' use of the credits.[25]

Some states have sought to develop model statewide articulation agreements so students can take their credits to more public colleges in the state. Because many IT certification classes are fairly standardized, they can easily be included in statewide agreements where those agreements exist. For example, Texas has developed a Statewide Articulation Program (SWAP) that encourages two-year colleges in the state to accept credit from any high school that offers certain courses. According to the state staff members involved in this effort, IT certification classes were among the first courses included in the SWAP because both state staff members and colleges could clearly establish which skills they covered. State staff members help colleges participate by documenting that specific high school classes meet collegiate standards, providing training to college staff members about how articulation works, and creating a standardized high school and

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(continued)
[24]The main function of the approximately 440 Cisco Regional Academies in the United States is to provide instructor training and technical assistance to the 4,500 Cisco Local Academies.

college course numbering system.[26] Developing these types of articulation agreements in other states could make it easier for high school students participating in high school certification programs to continue their preparation for IT credentials and jobs after they graduate, regardless of how many certification courses they are able to complete during high school.

- ***Although for-credit college certification classes count toward degrees, non-credit classes are more responsive to new certification requirements and students' diverse schedules.***

Many community colleges seek to offer a menu of classes that collectively serve diverse student needs. For-credit IT classes are typically designed to help students attain academic two-year degrees. Some IT departments also offer shorter programs that include the for-credit certification classes and that lead to certificates conferred by the college. Colleges' continuing education or workforce development divisions often offer non-credit IT classes designed to accommodate the education needs of various groups, including adults seeking to reenter the workforce or change careers and IT employees who need to upgrade their skills. The distinct purposes of for-credit and non-credit IT classes is reflected in the curricula, schedules and costs of these classes.

The content of for-credit IT certification classes is often shaped by the demands of a broader program of study and academic institutional review procedures whereas non-credit IT classes tend to have more flexible curricula and can be developed more quickly. Most colleges have a formal process for reviewing changes in IT degree programs, which can slow down the

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(continued)
[25]The actual use of articulation agreements by students will be discussed in chapter IV.

[26]Although colleges are not required to participate in this program, the state has succeeded in persuading many of them to do so.

introduction of new credit-bearing certification classes.[27] In contrast, non-credit classes can often can be introduced rapidly because little institutional review is required. Moreover, the college divisions that manage non-credit classes can often quickly hire instructors on short-term contracts or retain outside vendors to deliver instruction. Because the case study non-credit IT programs were flexible in these respects, many of the certification classes were offered first as non-credit classes and then were incorporated into the for-credit IT degree programs.[28]

The schedule and pace of non-credit IT certification classes are also more flexible than those of for-credit classes. For-credit IT certification classes in case study schools typically followed the established college semester guidelines. Case study staff members reported that the pace of these semester-long classes is slow enough for students with limited IT background and moderate technical aptitude. In contrast, non-credit programs offer classes with a variety of schedules, ranging from a few weeks to an entire semester. The shorter classes tend to be considerably more intensive and are designed mostly for students with some IT skills and experience. Non-credit programs often also offered online courses that were designed for motivated students with busy or variable work schedules.

Because IT degree programs and the divisions responsible for non-credit classes sometimes operated independently, the degree programs were sometimes slow to grant credit for classes developed initially as non-credit classes. Moving a class from non-credit to for-credit status often required extensive review and staffing changes. Sometimes, schools offered non-credit and for-credit classes that covered essentially the same material. In some of these cases, the non-credit

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[27]Some of the case study colleges conferred certificates.

[28]In two colleges in which the non-credit division did not have a well-developed IT program, IT certification classes had been introduced by IT department faculty who were particularly

classes were more intensive and faster paced and, hence, more appropriate for students in IT jobs.[29] In two case study colleges, administrators responsible for non-credit IT classes noted that some participating students might benefit if they had the option to take some of these faster-paced, for-credit classes because they could be entitled to greater financial subsidies and could earn credit toward a degree.[30] In colleges that offer many non-credit IT classes, administrators may find it useful to review whether and how the school can offer credit for some of them.

- ***Staff members and students in the case study sites see a need for more hands-on activities and internship opportunities.***

As schools develop IT certification programs and define the range of competencies emphasized by the classes, they also need to adopt instructional strategies that engage students and help them master key skills. In the case study sites, program staff members tried to find software and other materials that were engaging and that matched students' skill levels. Although the certification companies supplied school staff members with most of the instructional software and other materials, some schools also used other materials.[31] Most case study instructors sought

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(continued)
eager to include certification classes in their degree programs. At the time of the site visits, nearly all case study colleges offered both for-credit and non-credit IT certification classes.

[29]According to case study staff members, colleges did not grant credit for these faster paced programs because their content had not been systematically reviewed by the IT department, they did not include assignments and tests, and they were taught by instructors from the continuing education or workforce department who may not meet the same academic standards.

[30]As discussed in chapter III, although non-credit programs appear to attract fewer students interested in earning a degree, some non-credit students report that they need a degree to achieve their career goals.

[31]At the time of the case study interviews, Microsoft did not require schools to use its official curriculum. However, in 2002, after Microsoft introduced its IT Academies, Microsoft required participating high schools and colleges to use at least one of the three main Microsoft

to introduce hands-on activities designed to help students learn how to apply skills in tasks that resemble those that IT professionals perform.[32] As part of the case studies, we examined three ways that programs sought to help students apply and extend IT skills: (1) using interactive software, (2) developing hands-on activities in labs and student clubs, and (3) offering internships to students.

Both staff members and students appear to appreciate software-based curriculum that is interactive and visually stimulating. These features can be particularly important at the high school level where students are sometimes impatient or easily distracted. Instructors and students in the case study sites generally found software more engaging when it included many diagrams and simulation activities. For example, students in the Cisco programs suggested that they particularly liked the computer simulations that allowed them to design parts of network systems. Students were somewhat less enthusiastic about the drills that focused on the definitions of technical terminology.[33]

In addition to interactive software, school staff members note that students can be engaged by and benefit from hands-on activities where students solve problems and apply skills. The most common hands-on activities were those involving setting up the hardware and software for computer networks. During the site visit focus groups, students in case study sites generally

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(continued)
curriculum packages. Several of the case study high schools purchased third-party Microsoft curricula or developed their own curricula using test preparation books.

[32]For example, hands-on exercises in the Cisco curriculum require students to configure network settings on a PC, connect PCs to a local area network, and configure and test switches.

[33]Terminology and reading level could be barriers to engaging students. Students and staff members noted that the density of Cisco terminology introduced during the first semester could be difficult for students to understand and sometimes contributed to the high attrition rate from the Cisco program. Similarly, some teachers in the high school case study sites felt the reading level of the Microsoft curriculum was too difficult for most of their students.

reported that these activities were quite helpful and should be expanded. Local employer partners interviewed during the site visits also suggested that students needed to spend more time applying skills in realistic tasks.

Some teachers noted that the limits on class time and instructor preparation time made it hard for them to assign enough hands-on exercises. These constraints sometimes prevented them from assigning attractive lab exercises built into the model Cisco, Microsoft or Novell curricula. Some school staff members also suggested that, although many of the Cisco and Microsoft labs were quite helpful, they would like to develop additional activities that involve complex, real-world problems like those that network administrators face.[34] However, the limited planning time available to instructors usually prevented them from developing any additional hands-on activities. College programs were more likely than high school programs to offer separate lab times, but lab facilities were sometimes available to students during only a few hours of the week.

Some clubs and IT competitions provide students with additional opportunities to apply technical, problem-solving and presentation skills while they perform practical tasks. For example, with the support of the local chamber of commerce, one case study school district offered weekly after-school IT club meetings where students could learn more about networking, web design, PC repair, and graphic design and could become eligible for summer internships in IT. The national Internetworking competition sponsored by SkillsUSA also allows students to compete for prizes by performing tasks and making presentations related to the Cisco, Microsoft

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[34]One college dean indicated that she hopes to develop a "vestibule training lab" in which students could role-play and work as a team on complex problems. However, creating that type of a lab would require the college to make a larger investment in hardware and software as well as provide faculty with enough time to formulate and manage these activities.

and Novell certification curricula. Although these opportunities may be promising ways to incorporate hands-on activities in IT, only a small portion of the students in the case study certification classes participated in either national or local club activities.[35]

Case study schools also developed internships, although these were often limited in both the range of skills they developed and the number of students who could participate. Although internships rarely offered students the opportunity to perform technically complex work on live IT systems (since employers cannot risk damage to these systems), they did provide students with a way to build their resumes, develop some basic IT skills, learn more about available IT occupations and confirm their interest in IT. While some students acquired placements with local employers, others worked for the school district installing or maintaining computers or computer networks.[36] However, most of the case study schools were unable to place more than a handful of students in any IT internships because of constraints on staff time, the limited contacts of most school staff members and administrative IT policies that prohibited students from working on schools main computer networks.

Seeing a need to expand internships, some case study schools recently began exploring new strategies to develop these opportunities. One district took advantage of a new private venture sponsored by Manpower (the temporary help firm) and RealSkills (a curriculum supplier) to

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[35]Complete national data on the prevalence of student participation in these types of clubs is not available. During the national 2002 Internetworking competition, which is cosponsored by Cisco and several other companies, only about 58 secondary and postsecondary students participated. However, substantially more (about 3,800) participated in the state and local competitions.

[36]Internships within the school have the advantage that students do not need to travel and IT instructors, who are familiar with students' strengths and weaknesses, can often function as students' supervisors.

provide students with temporary positions as PC technicians or help desk staff people.[37] In another district, Philadelphia, the staff members running the Cisco Regional Academy worked with a Cisco regional sales manager to develop internships in local nonprofit organizations. Cisco supported this initiative by offering to sell its hardware at a discount to nonprofits that allowed student interns to help install their Cisco cables. This initiative is noteworthy, in part, because it appears to be expanding both the number of internship opportunities in Philadelphia and the range of tasks student interns can perform.

Although students, employers and instructors all value hands-on learning activities and internships, program staff members sometimes need more resources to develop these opportunities, and students need more time to participate in them. The experiences of the case study schools suggest that IT vendors, temporary firms, nonprofits and other local partners may be able to help develop useful internships and other opportunities. School staff members need time to cultivate relationships with these partners, help identify appropriate positions and monitor students' experiences. However, students may have difficulty squeezing these additional applied activities into their schedules unless IT programs are reconfigured. In high schools, because of stricter academic graduation requirements and other demands on students, strengthening hands-on activities may require the paring back of other parts of the certification curriculum, perhaps including some parts relevant to certification exams.

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[37]RealSkills develops and markets curricula for the vendor-neutral Comptia A+ certification programs. Although this internship program focuses on students who have taken classes designed to prepare students for Comptia's A+ exams, some of these students also take Cisco, Microsoft or Novell classes. After graduating from high school, some students retained the temporary jobs while pursuing postsecondary education.

B. RESOURCES NEEDED FOR IT PROGRAMS

Before deciding to introduce a specific IT certification program, educators must consider its demands on resources. A new program may require schools to buy computer equipment, instructional materials and training for staff members. Which investments are needed to start a new IT program depends on a school's existing resources and organizational structure.

The visits to case study schools provided some lessons about IT program costs. Although some schools were unable to provide quantitative data on costs, all sites were able to identify their most significant resource needs. This information shed light on programs' need for (1) computer equipment; (2) teacher training; and (3) pooling of resources across college for-credit and non-credit classes. We examine each of these issues in the sections that follow.

- *Substantial computer equipment costs can be offset by using existing equipment or accessing special funding sources.*

Because they are focused on developing students' computer skills, IT programs often require various types of computer equipment. The equipment that case study programs used typically included not only PCs but also special computer servers and, for Cisco programs, routers and switches that Cisco usually provides at cost. Sometimes schools also had to rewire or reconfigure classrooms for the new equipment.

Significant costs for computer equipment among IT certification programs were common, and all the case study schools reported purchasing some of this equipment for their certification programs. In fact, for most of these schools, computer equipment was the largest start-up cost. The average expenditure was about $16,000 among high schools and $67,000 among colleges. High schools typically purchased equipment for one classroom whereas colleges were more

likely to purchase equipment for several classrooms. Typically, classrooms were equipped for about 20 to 30 students.[38]

Although computer equipment costs were significant, actual outlays varied with the type of IT certification program. Most of the basic Cisco Local Academy programs—which prepare students for CCNA certificates—spent between $11,000 and $50,000 for routers, switches and, in some cases, PCs or servers.[39] Equipment for the more advanced Cisco Certified Networking Professional (CCNP) program cost approximately $70,000.[40] Schools with Microsoft and Novell programs reported spending $5,000 to $7,000 for servers to be used for the certification program.

Schools sometimes kept equipment costs lower by using PCs originally purchased for other purposes. The cost of purchasing new PCs for a classroom ranged from $20,000 to $45,000, depending on the type purchased; thus, some schools simply used their existing computers and bought only the specialized networking equipment. However, where PCs were old, students could not run all the newest instructional software, and some programs ran slowly.

To purchase computer equipment, some case study schools relied on donations and grants. Sometimes certification companies provided equipment free. For example, the Philadelphia school district received donations from Cisco for nearly all the Cisco-specific equipment needed for its programs. These donations are part of Cisco's effort to make its programs more accessible

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[38]These estimates, based on reported costs from six case study high schools and seven case study colleges, may understate the actual costs of all the equipment used by students, particularly among colleges that had many IT programs and may not have reported all equipment costs.

[39]For about $11,000, schools could purchase from Cisco one "bundle" containing the routers and switches needed for a CCNA class. Some schools, particularly colleges, needed multiple "bundles" because they had more than one CCNA class.

[40]All the case study schools with these CCNP programs were community colleges.

to low-income school districts within federal Empowerment Zones.[41] Some of the other case study schools reported that equipment needed for their IT programs was donated by local businesses. State and federal grant funding sometimes helped schools buy computer equipment. At least half the case study schools reported that they received some type of grant funding to support the purchase of equipment for their IT program. The federal funding sources included TechPrep, Perkins, and School-to-Work.

Schools in districts with limited budgets may need help in acquiring the equipment necessary for an IT certification program. This situation raises the question of how the availability of local and external funding may be affecting the overall mix of schools that offer IT certification programs, an issue we touch on in chapter III.

- ***Teacher training for IT programs can require substantial school support and teacher dedication.***

IT certification programs require teachers with specialized knowledge and training. Ideally, before they start teaching a certification class, instructors should be familiar with the IT labor market, be aware of relevant existing and emerging technologies, have the knowledge and skills needed for certification tests, and know how to apply various instructional strategies for students' diverse learning styles. Most IT companies encourage schools to use only instructors who have been certified themselves or who are at least working toward their IT certification. Some IT companies—such as Cisco—also require teachers to complete a specific type of training. Cisco provides this training through its Regional Academies, which sometimes charge Local Academies for teacher workshops and other technical assistance. The complete Cisco training for

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[41]Many of these schools in Empowerment Zones do not have sufficient existing computer equipment or funds needed to purchase computer equipment or network and cabling equipment.

a new CCNA Cisco instructor typically requires 21 days of training at a Cisco Regional Academy. Although Cisco Regional Academies exist in nearly every state, teachers may need to travel and stay at a hotel during these training workshops.[42] Microsoft and Novell do not prescribe a specific training format but, instead, encourage instructors to complete some training and secure the certificate for which the class is designed to prepare students. Microsoft recently opened 16 new regional teacher training centers in various educational institutions. Although they perform a function similar to that of Cisco's Regional Academies, there are fewer of them, so teachers must usually travel farther for this kind of training.

Some teachers in the case study schools needed substantial training before they could teach the certification classes because most were not familiar with the material and many were new to IT. Most case study high schools and many for-credit colleges chose to retrain existing teachers rather than hire new ones, partly because they had had difficulties recruiting teachers with the qualifications to lead these classes.[43] Many teachers attended some intensive training courses to learn the material from the IT certification. These programs often included summer workshops or certification classes offered by other schools or private vendors.

Teachers sometimes devoted significant amounts of personal time to their own training, both when they started teaching the certification material and subsequently as they sought to learn new skills. Several case study teachers reported that they attended IT training programs during

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[42]Cisco is piloting a teacher training program that involves online training and fewer days of classroom training. Cisco also offers a fast-track, three-day training option for teachers who already have their CCNA certification. The training for the more advanced CCNP courses requires additional teacher training.

[43]The stiff competition among public and private schools for qualified IT certification teachers made it harder and more expensive to hire these instructors. The case study teachers were drawn from a wide variety of other disciplines and departments, including electronics, math

the summer without any compensation for their time. Even when schools paid teachers for their initial training, the teacher often had to use personal time to stay abreast of changes in technology and certification requirements, new instructional materials and other resources available to teachers or students. Recent changes in both Cisco and Microsoft programs induced some teachers to take new courses.[44]

Expecting teachers to upgrade their skills without any compensation can also pose risks. Where teachers had to devote personal time to training, they had less time available for other IT programs and school activities. Some teachers who decided to move to another school or leave the teaching profession entirely noted that they had insufficient time to carry out all their responsibilities while keeping up with important changes in IT technology.

The cost of initial teacher training varied depending on the training source, how much travel was required and whether teachers were paid to attend the training. The eight case study schools that tracked their teacher training costs reported spending up to $10,000 per teacher.[45] These costs typically covered vendor fees and travel expenses.[46] Most of the Cisco Regional Academies

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and even foreign languages. In the state of Ohio, the Department of Education created a program to help existing math and science teachers gain the state's required teaching certification for IT.

[44]For example, in schools that offered Microsoft networking classes, some of the instructors had to receive some training to understand the changes associated with the new Microsoft 2000 operating system. Although some of the Cisco Academy teachers needed training to review changes in Cisco curricula, the most intensive training occurred when Cisco teachers prepared to teach some of the new types of courses offered through Cisco Academies, including the Adobe Web Design class, Sun Java and Unix classes, Panduit Voice and Data Cabling class, and the IT Essentials class, which prepares students for the Comptia A+ exam.

[45]Only four high schools and four colleges were able to provide information on teacher training costs. Schools with higher training costs and those receiving some external funding for teacher training appeared to be more likely to track these costs.

[46]The other case study schools did not provide estimates of teacher training costs.

did not charge for training. Some teachers attended Microsoft and Novell classes delivered by private for-profit vendors.

In estimating the resources needed to support staff development in IT certification programs, school staff members should make sure they consider the amount of time teachers need to learn the certification skills, develop and adapt instructional materials, and keep programs up to date. Where schools choose not to pay teachers for the time they devote to training, administrators should be aware of the risk of underinvesting in teachers skills, undermining the quality of the program, or increasing teacher burnout and turnover.

- ***To use resources more efficiently, some colleges may need to increase coordination between for-credit and non-credit programs.***

Although for-credit and non-credit college IT programs often have distinct purposes, they generally require similar resources. As noted in the first section of this chapter, most for-credit IT programs are designed to help students develop a broad background in IT and earn a degree (or at least a college certificate) whereas most non-credit IT programs are designed to help workers secure specific skills and industry certificates. Despite their differences, for-credit and non-credit IT programs tend to use similar facilities and instructors with similar skills. Where a college operates both types of programs, the programs can share faculty, facilities and curricula. This kind of resource coordination can allow schools to achieve minimum class sizes, use equipment efficiently or offer a larger menu of classes.

Although coordination can be challenging, several case study colleges are working on ways to pool resources and develop more complementary for-credit and non-credit programs. One case study community college recently moved its for-credit IT department to the building that houses its non-credit IT classes, allowing the two programs to use the same IT labs and certification testing center. Another college's for-credit program now allows students to receive credit for a

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specific series of non-credit courses. Still another case study college recently instituted monthly meetings among staff members in the for-credit and non-credit departments to make sure that the two programs do not offer duplicate courses.

However, some for-credit and non-credit programs operate independently of each other, with entirely separate faculty, facilities and curricula. Case study school staff members noted two factors that sometimes contribute to this separation. First, the academic and workforce development "cultures" are quite different. The interest of for-credit programs in ensuring that curricula meet internal and external academic standards often conflicts with non-credit programs' emphasis on responding quickly to labor market needs. The resulting differences in perspective can impede communications about the curriculum and pooling of resources.

Second, sometimes financial considerations can reinforce the tendency to keep the two types of programs distinct. Some states provide Perkins funding only to for-credit programs, partly because Perkins performance measures emphasize earning degrees and other credentials.[47] Even when for-credit IT departments are willing to share resources, they sometimes have to make sure that Perkins funds do not subsidize non-credit programs. Salaries also differ between the two divisions of the school, and this situation can make it harder to share faculty. The case study non-credit programs usually had great flexibility in setting salary levels whereas most of the for-credit programs had to stick to the colleges' standard salary scale.

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[47]This tendency to use Perkins for only for-credit programs reflects federal Perkins performance criteria, which emphasize helping students earn degrees or certificates. Although these performance measures cover not only educational institutions' credentials but also industry certificates, in practice, institutions have difficulty tracking students' acquisition of those certificates (see discussion in the next section). Consequently, states and colleges have more difficulty accounting for the positive credential outcomes associated with non-credit IT programs.

Better coordination and increased institutional flexibility might help some colleges' for-credit and non-credit programs prepare students for IT careers. College administrators may need to encourage their for-credit and non-credit divisions to pool more resources, ensure that students are aware of course offerings in both areas and develop complementary programs. In addition, state and federal supporters of these programs may be able to encourage more coordination by providing more flexibility in how colleges use grant funds or by broadening performance criteria to reflect the potential benefits of both for-credit and non-credit classes.

III. STUDENT ACCESS AND PARTICIPATION

Many schools have sought to make vocational programs accessible and relevant to a broad student population. These programs have historically been designed for students who want to enter the labor market shortly after completing high school and do not expect to earn a four-year college degree. Although interest in making sure vocational programs continue to serve this group is still widespread, some schools have also sought to make these programs relevant to at least some high-achieving students interested in both developing occupational skills and earning

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KEY FINDINGS

- ***IT certification programs are prevalent among both high schools and two-year colleges, but two-year college programs tend to serve more students.*** In the United States, a Cisco, Microsoft or Novell class is available in about 14 percent of all high schools and 25 percent of all two-year colleges. Enrollment in certification classes is larger in two-year colleges, in part, because these classes offer a broader menu and more complete sequences of certification classes than do high schools.

- ***Case study high school programs serve mostly students who have moderate academic achievement levels, partly because programs screen out some low achievers and few high achievers choose to participate***. To ensure that participants can handle the material, some schools discourage participation by those with low grades. Staff members say that some high achievers believe the class will not prepare them for college and so do not participate.

- ***Black and female students are underrepresented in IT classes.*** Although black students are more likely than white students to attend schools that offer Cisco, Microsoft or Novell classes, blacks students are less likely to take these classes. Females are also underrepresented. Schools are trying to increase the diversity in IT classes both by advertising their programs and by exposing more students to IT issues in earlier grades.

- ***The non-credit classes in case study colleges attract many students with IT work experience whereas for-credit classes often attract students who are changing careers.*** Both non-credit and for-credit students had substantial work experience, but non-credit students were more likely to have worked in the IT field and already have a bachelor's degree. However, about 11 percent of students taking non-credit classes indicated they were interested in earning a college degree. Community colleges might explore whether changing the format or schedule of for-credit classes could attract some students currently taking non-credit classes.

a bachelor's degree. Many factors can affect students' access to and participation in vocational programs, including the number and types of schools that offer them, the way they are advertised, and the prerequisites or other requirements students must satisfy. The box above summarizes this chapter's main findings.

Some supporters of certification programs are interested in ways to facilitate student access and participation. Making these programs more accessible could benefit both students who are interested and employers who would like to be able to choose from a large pool of people with specific skills. The number and mix of students who participate in a career-focused class reflects not only who has access to the class but also how students perceive it. Perceptions, in turn, can be affected by social norms within a school and by student views about the types of work the class entails. Examination of these factors may help staff members clear up misconceptions or address social norms that impede participation of certain groups.

In addition to identifying impediments to student involvement in IT classes, analysis of student participation may also indicate how new and expanding vocational programs are responding to changes in the postsecondary ambitions of students. As growing numbers of students seek to enroll in college, vocational educators have tried to modify occupational programs in ways that will appeal to both college-bound students and those planning to enter the labor market shortly after high school. The success of IT certification programs in appealing to diverse students may shed light on whether and how vocational programs can maintain their relevance to various groups of students in the future.

This chapter examines student access to and participation in IT certification programs. The results presented here are based largely on the lists of IT programs supplied by the certification companies, the national IT survey, the case study student survey and the site visits to case study schools. The two main sections of this chapter focus on two sets of questions:

1. ***Access.*** How many and which schools offer IT classes, and how does this affect the number and mix of students who have access to them?

2. ***Participation.*** How many and which students take these classes, and how do schools' screening procedures affect the mix of participants?

A. NUMBER AND MIX OF SCHOOLS WITH IT CERTIFICATION CLASSES

The accessibility of IT certification programs depends largely on their prevalence and location. Students can more easily learn about and decide whether to participate in these programs if they attend a school that offers one of them. Of course, students who live in areas that offer a choice of high schools or two-year colleges may be able to investigate and participate in programs in several schools, but this can require substantial effort on the part of students or their parents. Thus, the location of IT programs can affect which students can easily participate.

To gauge the number and mix of students who have the most direct access to Cisco, Microsoft and Novell programs, we examined the number and mix of schools that offer them. The secondary data available for this analysis allowed us to examine the relationship between the likelihood of offering certification programs and the characteristics of high schools and two-year colleges. The following three sections discuss study findings relating to (1) the number of schools that offer IT certification classes, (2) the association between offering one of these classes and the size of schools and population density of the community; and (3) the race, ethnicity and eligibility for school lunch of students enrolled in schools with these classes.[48]

- ***Many high schools and two-year colleges already offer at least one certification program.***

The portion of schools offering certification classes is one useful indicator of their accessibility to students. By combining lists of programs provided by Cisco, Microsoft and

Novell with public data on the number of high schools and colleges, we derived estimates of the portions of schools that offer one of these programs. As discussed next, and as summarized in Table III.1, although IT certification is a recent phenomenon, IT certification programs appear to be common in both high schools and two-year colleges, which suggests that many students have an opportunity to participate.

IT certification programs—particularly Cisco's—are offered in many high schools. By May 2000–2001, a Cisco, Microsoft or Novell program was operating in 2,982 high schools in the United States. This figure represents about 14 percent of U.S. schools that have a 12th grade.[49] At the high school level, Cisco programs are more numerous than those of Microsoft or Novell. The number of Cisco programs in May 2001 was more than 17 times the number of either Microsoft or Novell programs (see Table III.1).

Certification programs are also found throughout postsecondary schools, although more among two-year than four-year colleges. About one quarter of all two-year colleges and 10 percent of all four-year colleges offered a Cisco, Microsoft or Novell class in May 2001. The broad availability of certification classes at two-year colleges reflects the responsiveness of these institutions to demands for new types of credentials, particularly those that do not require a bachelor's degree.[50]

TABLE III.1

NUMBER AND PERCENTAGE OF HIGH SCHOOLS AND COLLEGES
WITH IT CERTIFICATION PROGRAMS

	Type of IT Program			
	Cisco	Microsoft	Novell	Any of Three
High Schools				
Number With IT Programs	2,731	169	166	2,982
Percentage With IT Programs	12.7%	0.8%	0.8%	13.9%
Two-Year Colleges				
Number With IT Programs	746	505	101	1,079
Percentage With IT Programs	17.4%	11.7%	2.3%	25.1%
Four-Year Colleges				
Number With IT Programs	147	251	28	381
Percentage With IT Programs	3.9%	6.6%	0.7%	10.0%
Two- and Four-Year Colleges				
Number With IT Programs	893	756	129	1,460
Percentage With IT Programs	11.0%	9.3%	1.6%	18.0%

Source: Cisco, Microsoft and Novell lists of programs operating by summer 2001, the Common Core high schools database for school year 1999–2000, and the Integrated Postsecondary Education Database for school year 1998–1999.

The large number of IT certification programs in operation by school year 2000–2001 is surprising, considering that most of them were introduced after fall 1997. Although Novell created the first certification programs in high schools and colleges in the late 1980s, Cisco and Microsoft did not develop their school programs until the mid-1990s. Only 5 percent of the high schools and 20 percent of the colleges that now operate certification programs reported having introduced a Cisco, Microsoft or Novell program before school year 1997–1998.

The number of IT certification programs is large compared with some well-established types of vocational programs designed to prepare students for credentials that were developed by

employers. For example, the Automotive Service Excellence (ASE) certificates and accreditation standards are one of the most well established program and student assessment standards developed by industry. These standards were developed in the early 1970s but were enhanced during the 1980s, after which the number of ASE programs rose substantially.[51] However, in 2001, there were still only 1,628 ASE-certified programs.[52] In contrast, by 2001, about 4,061 high schools and two-year colleges had Cisco, Microsoft or Novell certification programs, and many more private proprietary schools also had these programs. Moreover, many other schools have other types of IT certification programs such as those designed to prepare students for Comptia or Oracle certifications.

The prevalence of IT certification programs suggests that they have the potential to affect the way many students prepare for IT careers. Of course, this potential depends partly on how many students actually participate, an issue we examine in the following section.

- ***Large schools and schools in densely populated areas are more likely to offer IT certification classes.***

Larger schools and school districts often have less difficulty than smaller ones developing programs for students with specific interests or aptitudes. When schools and districts serve a large overall student population, they can more easily recruit students with the relevant interests and skills. In addition, larger schools or districts sometimes have the technical expertise or other resources needed for development of specialized programs.

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[51]As of 1990, more than 20 years after these standards were introduced, only 398 ASE programs were in the United States.

[52]This count includes all ASE automobile, truck and collision repair programs in all types of schools, including secondary, public postsecondary and private schools. The number of schools containing ASE programs is smaller because some schools have more than one type of program.

Reflecting these advantages of scale, the high schools and two-year colleges that offer Cisco, Microsoft and Novell classes tend to be considerably larger than the average high school and two-year college in the United States. The analysis of the Cisco, Microsoft and Novell school lists indicates that 28 percent of all high schools with more than 1,000 students offer one of these three certification classes, considerably more than the rate among smaller schools (see Table III.2). Similarly, two-year colleges with more than 1,000 students are more likely to offer certification classes than smaller colleges (Table III.3).

Because so many large schools offer certification classes, a large percentage of high school and college students have direct access to them. About 23 percent of all high school students, 19 percent of four-year college students, and 52 percent of two-year college students attend a school that offers a Cisco, Microsoft or Novell class. These percentages are substantially larger than the percentage of schools that offer one of these classes because certification classes are concentrated in the largest high schools and colleges.

At the secondary level, school districts with greater population densities are also somewhat more likely to offer certification programs. IT certification classes are most common in cities and least common in rural areas (see Table III.2). This distribution may reflect the fact that urban magnet programs can more easily recruit enough students who have relevant interests and live nearby than can schools where students are dispersed.[53] Community colleges in densely populated areas are no more likely than other colleges to offer certification programs, perhaps, because colleges in rural areas can attract students from a wider area than can rural high schools (see Table III.3).

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[53]We have not explored whether the concentration of IT certification programs in urban schools is related to the relative size of the high schools in urban, suburban and rural areas.

TABLE III.2

PERCENTAGE OF HIGH SCHOOLS WITH IT CERTIFICATION PROGRAMS,
BY SCHOOL CHARACTERISTIC

	Percentage of High Schools With the Following Kinds of IT Certification Programs				Percentage Distribution of Schools in United States by Characteristic
	Cisco	Microsoft	Novell	Any of Three	
All Schools	12.6	0.8	0.8	13.7	100.0
School Size:					
1–500	6.1	0.3	0.3	6.6	54.2
501–1,000	13.7	0.9	1.0	15.1	21.0
1,001+	25.6	1.7	1.5	27.9	24.8
Type of School:					
Regular	13.9	0.7	0.7	15.1	79.6
Vocational School	36.7	4.8	4.2	41.5	3.5
Other (Includes Special Ed)	1.3	0.2	0.1	1.7	17.0
Region:					
Northeast	14.1	1.3	0.3	15.3	12.8
Midwest	11.3	0.3	0.9	12.2	29.4
South	12.0	0.7	0.9	13.1	35.3
West	14.3	1.2	0.7	15.7	22.4
Locality:					
City	16.3	1.1	0.8	17.7	19.6
Urban Fringe	13.4	1.1	1.1	15.1	26.8
Town	14.3	0.7	0.7	15.3	15.4
Rural	9.3	0.4	0.5	10.0	38.3

N = **21,746**

Source: Cisco, Microsoft and Novell lists of programs operating by summer 2001 and the Common Core database for school year 1999–2000.

TABLE III.3

PERCENTAGE OF TWO-YEAR COLLEGES WITH IT CERTIFICATION PROGRAMS,
BY SCHOOL CHARACTERISTIC

	Percentage of Colleges With the Following Kinds of IT Certification Programs				Percentage Distribution of Colleges in United States by Characteristic
	Cisco	Microsoft	Novell	Any of Three	
All Schools	17.4	11.7	2.3	25.1	100.0
School Size:					
1–1,000	4.5	6.8	0.8	10.6	58.1
1,001–4,999	33.4	15.8	4.2	43.3	26.3
5,000+	38.3	23.5	5.1	48.4	15.6
Region:					
Northeast	7.3	6.5	0.8	13.2	19.8
Midwest	13.3	10.5	3.0	21.4	27.5
South	24.5	13.0	2.2	32.1	32.4
West	21.3	16.5	3.3	30.6	20.4
Locality:					
City	14.5	12.2	2.7	23.2	47.9
Urban Fringe	16.7	12.9	1.9	24.2	24.8
Town	22.6	9.8	1.9	29.3	22.4
Rural	24.8	10.2	3.1	29.5	4.9

N = **4,298**

Source: Cisco, Microsoft and Novell lists of programs operating by summer 2001 and the Integrated Postsecondary Education database for school year 1998–1999.

If substantial economies of scale can be achieved in implementing IT programs, then school staff members interested in creating an IT certification program may want to consider whether their school or district is large enough and has the resources needed to sustain such programs. Of course, some factors can compensate for school and district size. For example, smaller schools that already have a well-established IT program or that already have many students interested in IT careers may be well situated to develop certification programs.

- ***Black and Hispanic students are at least as likely as white students to attend schools that offer IT certification classes.***

Some educators have suggested that economically disadvantaged students have the most to gain from IT certification programs. Many high school IT programs are designed to help students secure decent jobs, regardless of whether they attend college. Hence, there is some interest in how available IT certification programs are in schools and districts that serve minority and low-income students. To examine this issue, we used student data from the Common Core and IPEDS to estimate the percentage of black, Hispanic and white high school and two-year college students enrolled in schools that offer Cisco, Microsoft or Novell classes. Although neither of these data sources provides much information on the economic status of students, the Common Core does provide information on the portion of high school students whose family income is low enough to make them eligible for free or reduced-price lunches (that is, families with incomes below 185 percent of the poverty level).

In terms of the location of IT certification programs, minority students in high schools and colleges have at least as much access to IT certification classes as do their white peers. Among high school students in the United States, approximately 26 percent of all blacks and 30 percent of all Hispanics, in contrast to 22 percent of whites, are enrolled in a school that offers a Cisco, Microsoft or Novell class (see Table III.4). Among postsecondary students, the percentage of

TABLE III.4

PERCENTAGE OF HIGH SCHOOL STUDENTS IN SCHOOLS OFFERING
CERTIFICATION PROGRAMS, BY RACE AND ELIGIBILITY FOR
FREE AND REDUCED-PRICE LUNCH

	Percentage of Students in Schools With Each Type of Program				Percentage of Students in U.S. High Schools
	Cisco	Microsoft	Novell	Any of Three	
All Students	22.4	1.4	1.4	24.0	100.0
Race/Ethnicity:					
Black (Non-Hispanic)	24.4	0.9	1.3	25.8	15.4
Hispanic	29.1	0.9	0.9	30.3	14.2
White (Non-Hispanic) and Other	20.7	0.9	1.5	22.3	70.4
Free and Reduced-Price Lunch Eligibility:					
Eligible	23.7	1.3	1.0	24.8	22.0
Not Eligible	22.1	1.4	1.5	23.7	78.0

Source: Cisco, Microsoft and Novell lists of programs operating by summer 2001 and the Common Core database for school year 1999–2000.

blacks and Hispanics enrolled in a two-year college with an IT certification class is very close to the percentage of whites enrolled in these schools (see Table III.5).

Black students' access to IT certification programs is probably heightened by the fact that these programs are concentrated in urban areas where black students are more likely than white students to go to school. Because urban schools are more likely than others to offer IT certification programs (and particularly Cisco programs), black students' access to these programs is greater.

The large concentration of Cisco and Microsoft programs in California and Texas also improves Hispanic students' access to IT certification. High school students in California and Texas are more likely than those in other states to attend schools that offer a Cisco or Microsoft

TABLE III.5

PERCENTAGE OF COLLEGE STUDENTS IN SCHOOLS OFFERING
CERTIFICATION PROGRAMS, BY RACE AND ETHNICITY

	Percentage of Students in Schools With Each Type of Program				Percentage of Students in U.S. Colleges
	Cisco	Microsoft	Novell	Any of Three	
All Students	40.3	24.1	5.6	51.6	100.0
Race/Ethnicity:					
Black	39.2	20.2	5.4	48.8	11.5
Hispanic	40.5	22.8	6.8	52.4	11.8
White/Other	40.4	24.9	5.5	52.0	76.3

Source: Cisco, Microsoft and Novell lists of programs operating by summer 2001 and the Integrated Postsecondary Education database for school year 1998–1999.

program (but slightly less likely to attend Novell schools).[54] The concentration of Hispanic students in California and Texas increases their access to Cisco and Microsoft programs.

Low-income high school students are just as likely as other students to attend schools that offer IT certification programs. Specifically, students whose family income is low enough to qualify them for free or reduced-price lunch are just as likely as other students to attend a school with a Cisco, Microsoft or Novell class (see Table III.4). However, more than 20 percent of all schools do not report on the number of students eligible for school lunch subsidies. Hence, these figures are only a rough measure of low-income students' access to IT certification programs.[55]

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[54]However, Texas and California contain a much larger percentage of Novell two-year colleges than Novell high schools; consequently, Hispanic college students have greater access to Novell programs than do Hispanic high school students.

[55]Data on the number of students eligible for free or reduced-price lunch are available for only 61 percent of the IT schools and 79 percent of all schools nationwide. Moreover, audits of schools suggest that the data that schools do report on school lunch eligibility rates often do not accurately reflect families' real income levels.

The prevalence of certification programs—and particularly Cisco programs—in low-income communities with large minority populations may be partly because of Cisco's policy of providing free lab equipment to schools in Empowerment Zones.[56] According to Cisco's Web site, 183 Cisco Academies in 30 of the nation's 40 Empowerment Zones have taken advantage of this policy. In several large school districts, Cisco has provided free equipment to multiple schools; for example, six or more schools have secured free equipment in Baltimore, Chicago, El Paso, Houston, Los Angeles, New York, Philadelphia and the District of Columbia. In addition, Cisco has given free equipment to some Cisco Academies in low-income rural areas, including several communities with large concentrations of Hispanics.

Although these findings indicate that minority and low-income students are at least as likely as other students to attend schools that offer IT certification programs, their access to these programs could be impeded in other ways. For example, certification class prerequisites or other requirements could prevent students from participating. In any case, access is clearly different from participation. Thus, it is useful to gauge the extent to which a diverse mix of students actually enrolls in certification classes, an issue we examine next.

B. STUDENT PARTICIPATION IN CERTIFICATION CLASSES

The range of students who benefit from occupational programs depends in part on the number and mix of students who participate. If certain segments of the student population cannot or choose not to participate, then those students clearly do not currently benefit from the program. Although we do not yet know the extent to which IT programs can improve the postsecondary outcomes of any group of students, the recruitment and screening procedures of

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[56]As noted in chapter I, Cisco offers free routers, switches, and other networking equipment to Cisco Academies in schools in low-income Empowerment Zones.

schools reflect staff members' current views about which groups of students are most likely to be interested in these classes and able to succeed in them.

In assessing the importance of IT certification programs, a useful first step is to gauge how many students are currently participating in them. We address this assessment in this section by combining the National IT Survey results with information from the Common Core and IPEDS. These data provide estimates of the portion of students who take at least one Cisco, Microsoft or Novell class.

Some of those who promote IT certification programs in schools say that these programs represent valuable opportunities for students who have had difficulty in their academic classes. For example, some of the initial designers of both the Microsoft and Cisco IT high school programs encouraged school administrators to try to recruit at least some at-risk students who are not doing well academically (Aoki 1997; Cisco 2002). These program advocates suggest that the hands-on IT curriculum can engage some of these students. However, they do not suggest that IT programs should serve lower-achieving students exclusively. Instead, they simply would like recruitment and screening efforts to be configured so students who have not done well in academic classes can take advantage of IT programs.

Some educators have suggested that IT programs should try to attract minority and female students because these groups are underrepresented in IT jobs (Freeman and Aspray 1999; National Science Foundation 2000; *Certification Magazine* 2002). By breaking down stereotypes and preparing more minority and female students for IT positions, programs potentially can benefit not only these students but also employers who have had difficulty filling IT positions. National transcript analyses suggest that, during the early 1990s, high schools succeeded in reducing the gender gap in many types of computer programs, although little study has been done of the mix of high school or college students participating in IT certification classes like

those designed to prepare students for Cisco, Microsoft and Novell certification tests (Silverman et.al.2002).

At the community college level, some educators are interested not only in continuing to serve students who have recently completed high school but also in upgrading the skills of various groups of adults, including those changing careers and seeking to advance within their current field. As discussed in chapter II, college IT certification programs—and particularly non-credit programs—often try to accommodate various groups of students, including adult workers. The mix of students these programs succeed in serving can shed light on the emerging role of these programs in local labor markets.

The IT study provides some information on how well IT high school and two-year colleges are succeeding in attracting various groups of students to certification classes. Here, we draw on data from both the National IT School Staff Survey and the case study IT student survey.[57] We next examine the overall size of certification programs and then discuss findings pertaining to the ways schools screen students for IT certification programs, the degree to which minority and female students participate, and the mix of students attracted to community college programs.

- ***Two-year colleges have larger and more complete certification programs than do high schools.***

Total enrollment in IT certification classes reflects the number of students who not only have access to them but also choose to participate and can satisfy the prerequisites or other

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[57]Note that while the findings from IT School Staff survey are nationally representative, those from the Case Study IT Student Survey may not be. The latter survey may not be representative of all students enrolled in IT certification classes for two reasons. First, the survey is not nationally representative. Second, it surveyed only (1) high school students who completed an IT certification class during their senior year, and (2) community college students in their last class before completing an IT certification sequence.

requirements. We provide four main measures of the size of programs: (1) median and average enrollments in all Cisco, Microsoft and Novell classes in the schools that offer them; (2) the percentage of students in these schools who enroll in at least one of these three types of classes; (3) the percentage of all students who enroll in one of these classes; and (4) the total number of students who take one of the classes. We first examine the size of high school programs and college programs.

Most high school IT certification programs are of modest size, which suggests that they are attracting a narrow segment of the student population. For school year 2000–2001, the median school responding to the National IT School Staff Survey indicated that the total number enrolled in any of its Cisco, Microsoft and Novell classes was only 24, and the average was 31.[58] Only one of five high schools responding to the survey enrolled more than 40 students in their Cisco, Microsoft and Novell classes. Overall, 2.2 percent of all high school students in schools that offer IT certification classes enrolled in one. Because about 24 percent of all high school students in the United States attended schools with certification classes, about 0.5 percent (0.24 times 2.2) of all high school students enrolled in at least one Cisco, Microsoft or Novell class.

The small average size of high school certification programs reflects, in part, the narrow range of certification classes offered in many schools. Some schools offer only a subset of the classes needed to prepare for even the most basic certifications. For example, about 35 percent of all high schools with Cisco, Microsoft and Novell classes did not offer all the classes needed for preparation for a single certification in school year 2000–2001. Only 10 percent of high schools offered all the classes needed for preparation for more than one certification.

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[58]These figures are the combined enrollment in all classes. For high schools, it covers all grades. In colleges, it includes each class in the sequence designed to prepare students for certification.

Although the size of the average high school program is fairly modest, and only a small portion of all high school students participate in these programs, the total number of participants in the United States is substantial, particularly when compared with some other vocational programs organized around assessments developed by industry. The average enrollment estimates suggest that approximately 92,000 high school students participated in Cisco, Microsoft and Novell classes during school year 2000–2001. This number is probably larger than the enrollment in many other types of vocational programs based on industry standards. For example, rough estimates supplied by ASE suggest that probably about 16,000 students enrolled in all ASE automotive repair high school programs in school year 2000–2001.

Postsecondary IT certification programs tend to be larger than high school programs. In the median two-year college offering at least one Cisco, Microsoft or Novell class, these types of classes enrolled about 102 students, and the average enrollment for a college was 250.[59] One out of five of these schools enrolled more than 350 students. About 2.5 percent of all the students in two-year colleges with IT certification programs took one of these classes. Because about 52 percent of all two-year college students in the United States are enrolled in schools with certification classes, about 1.3 percent (.52 times 2.5) of all two-year college students took a Cisco, Microsoft or Novell class. These estimates imply that a total of about 270,000 two-year college students were enrolled in one of these classes during school year 2000–2001.

IT programs in two-year colleges tend to be larger than those in high schools, partly because the colleges offer a broader array of certification classes. About two-thirds (64 percent) of the colleges with Cisco, Microsoft and Novell classes indicated that they offer all the classes needed

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[59]If one excludes an outlier college reporting enrollment of 7,000 students in IT classes, then the average IT enrollment is 217.

for preparation for at least two distinct certificates. Nearly all the rest provided every class needed for at least one certification. Providing opportunities to take a larger number of specialty certification courses probably makes more sense in colleges than in high schools because postsecondary students usually have had more opportunities to confirm their interest in specific IT jobs. Moreover, high school students can complete their preparation for certification classes after they leave high school.

- ***Case study high school programs tended to attract students with moderate levels of academic achievement.***

When school staff members develop a new program, they must decide whether and how to screen interested students. Screening can be either formal (specifying specific prerequisites or grades needed to take a specific class) or informal (encouraging or discouraging students with specific interests and aptitudes to consider taking a class). Screening can be helpful if many of the students who indicate interest do not have the skills or motivation to take full advantage of the curriculum. However, school staff members may have difficulty predicting which students are most likely to be engaged by the curriculum and benefit from the program. As a program matures, school staff members may be able to refine screening procedures as they gain more information about factors that predict whether students are likely to have difficulty in a program or whether they will drop out of a program.

At least during the early stage of program development, several of the case study high schools had high rates of attrition. Some of the Cisco programs lost about a third of their students during the middle of students' first year in the program and another third between students' first and second years. In schools where the Microsoft program consisted of two or more semesters of

classes, some of these programs had similar attrition levels.[60] According to staff members in schools with high attrition, many students who were initially attracted to the programs did not have a clear sense of the curriculum, and many did not possess the relevant skills.

Some case study schools, after implementing an IT certification program for a year or more, decided to discourage students with very low math and reading grades from participating because, in the past, many of these students had not been successful. Some had dropped out because they could not handle the material or did not enjoy it. Others could not complete the sequence of classes because they had to take many academic courses in their senior year to meet graduation requirements. To make sure students had minimum math and reading levels, some schools instituted formal procedures for screening out students with weak math and reading grades whereas, in other schools, guidance staff members simply discouraged students with poor basic skills from participating. Some schools required students to complete an introductory IT class designed to acquaint them with some of the terminology and confirm their interest in the more specialized certification classes. In these cases, students with weaker grades could take the certification class as long as they completed the introductory IT class successfully.

Nationally, most high school certification programs have some academic or IT class prerequisites for certification classes, and these prerequisites may screen out many students (see discussion in chapter II). Most of the case study schools had some formal or informal screening whereas other schools specifically chose not to screen out interested students and relied more on students' own judgment to determine whether they could benefit from the classes. For example,

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[60]The Novell case study high school programs usually consisted of only one or two semester classes; consequently, those programs had less attrition.

several of the Philadelphia schools with Cisco programs chose not to screen students as long as they appeared to be on track for graduating from high school.[61]

While several schools discouraged the lowest-achieving students from participating, the highest-achieving students often chose not to participate. According to school staff members, many college-bound students with an interest in IT were reluctant to enroll in the certification classes either because they attached a general stigma to vocational programs or because they perceived other classes to be more helpful in their preparations for college. In addition, in the four case study sites where the IT class was offered in a separate regional vocational school, staff members reported that the students with the busiest academic schedules sometimes found it difficult to get from their home schools to the vocational school for part of the day.

Consistent with these staff reports, participants responding to the student survey in our case study sites were somewhat less likely than the overall population of all high school students to enroll in college right after high school. The follow-up survey—conducted two years after most case study students left high school—indicated that only about 48 percent of the IT program participants enrolled in a two- or four-year college (see chapter IV for more information on the postsecondary outcomes of case study students). Comparisons with recent national surveys of high school students suggest that a substantially larger portion of all high school graduates enroll in college within two years after high school.[62]

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[61]The decision of these schools not to screen students was made both to provide opportunities to some at-risk students who could be engaged by IT certification and to attract more students to certification classes that were serving small numbers.

[62]For example, the National Educational Longitudinal Survey (NELS) indicates that approximately three quarters of all students in the Class of 1992 enrolled in a two-year or four-year college class within two years of leaving high school.

Reflecting both the screening of low achievers and the diversion through self-selection of high achievers, most of the case study students tended to have moderate grade point averages (GPAs) and math achievement levels. The case study survey asked students for their cumulative GPA in high school and the last math class they took before graduating.[63] The vast majority of students reported GPAs clustered around a B (see Table III.6). In addition, most students (63 percent) reported their last high school math class to have been algebra II, geometry, or trigonometry—all courses of moderate math achievement. This pattern probably reflects the combined efforts of program screening and student self-selection.

As schools develop new IT certification programs and modify their existing programs, staff members may need to revisit whether and how they screen students. Given the expense of IT programs, schools need to continue to discourage participation of students who are clearly unable to handle the material and who tend to drop out of programs quickly. However, schools may want to avoid using simple screens such as excluding all students with low math or reading grades, even though these kinds of screens are often easy to apply in practice. Although case study teachers indicated that students with low grades often had more difficulty with the material, several teachers noted examples of students who had not been successful academically but had performed well in the certification class. In the absence of any findings indicating which groups of students are most likely to benefit from certification classes, educators might try to explore ways of providing some opportunities for those with weak academic performance. For example, schools that need to screen students could require those with marginal skills to take

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[63]Because students may not recall or report their grades accurately, one must be cautious in interpreting these data. Nonetheless, the grade distribution for the case study student survey respondents appears to be more closely clustered around a B average than is typical of self-reported grades from other nationally representative student surveys such as the NELS 10th grade survey conducted in 1988.

TABLE III.6

ACADEMIC ACHIEVEMENT OF CASE STUDY HIGH SCHOOL STUDENTS
WHO TOOK IT CERTIFICATION CLASSES

	Percentage
Average High School GPA	
3.66 to 4.0	11
2.66 to 3.65	76
1.66 to 2.65	12
Last Math Course in High School	
Algebra I	6
Algebra II, Geometry, Trigonometry	63
Calculus, Precalculus	26
Business Math, Statistics	5
Sample Size	**96**

Source: Case Study IT Student Survey, 2002, Princeton, N.J.: Mathematica Policy Research, Inc.

[a]Some respondents had more than one of these outcomes.

introductory IT classes in which they could demonstrate their ability to master technical terminology and principles.

- ***Nationally, minority students enrolled in schools offering IT classes have somewhat lower participation rates than their white peers.***

Although black and Hispanic students appear to have access to certification programs, their rates of participation can be affected by many factors. As noted earlier, minority students are slightly more likely than whites to attend schools with Cisco, Microsoft and Novell classes. Among students in these schools, participation in certification classes can be affected by school screening procedures, the extent to which students are aware of the classes and the careers associated with them, their interest in those careers, and their ability to satisfy IT class

prerequisites. The national IT School Staff Survey provides some estimates of the participation rates of black, Hispanic and white students enrolled in schools that offer Cisco, Microsoft and Novell certification classes. By combining these estimates with the secondary data on total enrollments by race in schools that offer certification classes, we are also able to estimate the portion of all black, Hispanic and white high school and two-year college students who are enrolled in certification classes in the United States.

Nationally, among those attending schools with Cisco, Microsoft and Novell classes, both blacks and Hispanic students appear less likely than their white peers to enroll in these classes, particularly at the high school level. Overall, among students in schools that offer one of the three certification classes, only about 1.5 percent of black students and 1.8 percent of Hispanic students enrolled in at least one Cisco, Microsoft or Novell class—significantly less than the 2.4 percent of white students who participated in one of these classes (see Table III.7). The two-year colleges that responded to the survey also indicated that minority participation was lower than that of whites, but the differences were not as large: about 1.6 percent of blacks and 2.3 percent of Hispanics in the two-year colleges enrolled in one of the three kinds of certification classes, compared with about 2.8 percent of whites.[64]

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[64]Consistent with this pattern, Table III.8 indicates that the percentages of minority students participating in IT certification classes is significantly smaller than the percentage of students enrolled in the schools that offer these classes.

TABLE III.7

PERCENTAGE OF STUDENTS PARTICIPATING IN CISCO, MICROSOFT OR NOVELL
CERTIFICATION CLASSES, BY RACE AND ETHNICITY

| Race/Ethnicity | Among Students in Schools With Certification Classes | | Among All Students in United States | |
	High School	Two-Year College	High School	Two-Year College
All Students	2.20	2.50	0.53	1.29
African American	1.50	1.60	0.39	0.78
Hispanic	1.80	2.30	0.55	1.21
White/Other	2.40	2.80	0.54	1.46

Source: These estimates were derived by combining data from MPR's National IT School Survey conducted in 2002, the high school Common Core database for school year 1999–2000 and the Integrated Postsecondary Education database for school year 1998–1999.

However, when one accounts for the fact that minority students are somewhat more likely than whites to be enrolled in high schools that offer certification classes, the gaps between overall minority and white participation in these classes begin to shrink. In fact, among students enrolled in all U.S. high schools, the rate of participation of Hispanics is comparable with that of their white peers, and the difference between black and white participation is not very large (see Table III.7).[65] However, among students in U.S. community colleges, the white participation rate remains substantially larger than that of blacks or Hispanics, even after taking into account the portion of students enrolled in schools that offer certification (see Table III.7).

The case study staff interviews suggest that several factors can reduce participation of minority students in schools that offer certification classes. Some staff members indicated that minority participation was hindered somewhat by IT class prerequisites or by a policy of

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[65]The fact that, within schools, Hispanics tend to participate somewhat less than their white peers is fully offset by the concentration of Hispanic students in schools that offer some certification classes.

TABLE III.8

RACE AND ETHNICITY OF STUDENTS PARTICIPATING IN CISCO,
MICROSOFT OR NOVELL CLASSES COMPARED WITH
STUDENTS IN SCHOOLS OFFERING THESE CLASSES

	High Schools		Two-Year Colleges	
Race/Ethnicity	Percentage of Students in Schools Offering IT Classes	Percentage of IT Class Participants	Percentage of Students in Schools Offering IT Classes	Percentage of IT Class Participants
African American	17.5	11.1*	13.2	9.7*
Hispanic	12.1	7.5*	10.9	8.9*
White/Other	70.4	81.4	75.8	81.4
Sample Size	**174**	**174**	**194**	**194**

Source: National IT School Staff Survey, spring 2002, Princeton, N.J.: Mathematica Policy Research, Inc.

*Difference between average percentage of subgroup among students in the school and percentage among IT participants is statistically significant at the 1 percent level.

discouraging students with very low achievement levels. Language barriers were important for some Hispanic students. Several case study teachers reported that students with limited language abilities sometimes found the IT terminology and online texts challenging. In at least one high school with many Hispanic students, the district produced only English-language versions of a brochure sent to families containing information on the IT certification classes and other vocational classes available in the district. This English version may have made it harder for Hispanic students or parents to learn about the program.

Some schools have increased efforts to reach out to minority students. For example, one of the case study schools, which advertised vocational programs through brochures sent to families, plans to produce these brochures in Spanish. Some community college programs place ads or

articles in targeted publications to reach minority populations. Continued outreach may be needed to increase minority participation in IT programs. In addition, schools could seek to help more students satisfy IT prerequisites and learn about the career opportunities available to those with IT skills and credentials.

- ***Women are underrepresented in most high school and college certification programs.***

Programs focused on specific careers sometimes need to overcome gender stereotypes. Some vocational programs, particularly at the secondary level, tend to be dominated by either males or females. For example, in 1998, males in high school were about six times as likely as their female counterparts to take trade and industry classes (which tend to focus on fields such as manufacturing, construction and automotive repair) whereas females were about four times more likely than males to take health occupation classes (National Center for Education Statistics 2000). Although previous national high school transcript studies suggest that the overall female participation in computer classes has grown substantially between 1982 and 1998 to the point where it is comparable with that of male students, males continue to dominate certain types of computer classes such as computer-aided design (Silverman et al. 2002). Studies of male and female vocational course-taking patterns have not focused on IT certification classes such as those designed to prepare for Cisco, Microsoft and Novell exams because, until very recently, these classes were rare. The extent that IT certification classes are dominated by males could reflect and reinforce stereotypes that discourage female students from participating.

The national IT School survey indicates that females are substantially underrepresented in both high school and college IT certification classes. In the median high school, females represented only 10 percent of all students taking Cisco, Microsoft or Novell classes. In two-year colleges, the comparable figure was only 15 percent. Across all responding schools, the average

percentage of female students in these three kinds of classes was 16 percent for high schools and 21 percent for colleges.[66]

In the case study sites, several factors appeared to contribute to the gender gap in student participation: social stigma, the tasks assigned to students, and differences in the learning styles of male and female students. According to several case study school staff members, some female students are reluctant to enroll in IT because they simply do not like being one of the few females in the class. Some school staff members suggested that the content of the class and the class dynamics can deter female students from participating or staying in the class. Several teachers reported that some of the physical networking tasks related to Cisco programs, for example, climbing a ladder to fix or install computer network cables above a classroom's ceiling, are not appealing to some of the female students generally interested in the IT field. In addition, female students sometimes had distinct learning styles that could have affected the way they experienced the class. For example, some instructors indicated that their female students tended to be more cautious in classroom discussions and, as a result, may have felt that they were not participating or learning as much as their male peers.

Although a few case study sites pursued strategies designed to increase female enrollment, they were usually unable to demonstrate much success. For example, several programs hired female instructors as positive role models. Some of the female Cisco teachers made a point of doing a lot of the cabling work around the school to try to show female students their interest in this kind of work and their ability to do it. Although these strategies may have been of some help, female participation in many of these schools remained low.

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[66]Similarly, case study IT classes had few female students participating: 24 percent in high schools and 30 percent in community colleges.

Although not very common, some schools have succeeded in recruiting substantial numbers of female students, and their experience may point to some promising strategies. About 10 percent of the IT certification schools responding to the National IT School Staff Survey. indicated that at least 50 percent of their students in Cisco, Microsoft and Novell classes are female. Although the national survey did not contain sufficient data to isolate how these schools succeeded in recruiting more female students, this information could be explored in future studies.

Cisco has instituted some promising practices designed to attract female students. Most of these strategies have been used by academies where a large percentage (30 percent or more) of the participants are female.[67] For example, a partnership in Seattle paired some female students with female IT professionals who described the opportunities in the field. Other schools exposed students in middle schools to IT issues and available high school certification classes. Still other schools asked guidance staff members to describe Cisco classes to female students who may be interested or sought to cultivate female student leaders who were willing to share information about Cisco with other students. Given the large gap between female and male participation in IT certification classes, educators and IT companies should continue to work together to identify strategies that can attract and retain more female students.

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[67]Although these strategies for attracting female students were not evaluated or identified through any statistical analysis, they may point to strategies that should be tested or more closely investigated. The strategies are described on Cisco's gender equity Web site.

- *For-credit and non-credit classes in case study colleges tended to attract students with substantial work experience, but for-credit students were more likely to be changing careers whereas non-credit students were often already in the IT field.*

Differences in the purposes and funding of for-credit and non-credit college programs can influence the mix of students they each tend to attract. As discussed in chapter II, for-credit and non-credit IT certification classes are often designed to accommodate students with somewhat different needs. For-credit IT college programs are typically designed mainly for students interested in preparing for a college certificate or degree (and may, in addition, help students secure an IT industry certificate such as a Cisco, Microsoft or Novell certificate). In contrast, non-credit programs are often designed for students who are not interested in any credential available through the school but who want to develop or upgrade their IT skills and prepare for certification tests. Because for-credit programs are more often subsidized—through federal Perkins funds, other state and federal grants to schools, and federal student grants and loans— these programs are often more accessible to lower-income students. Although most non-credit programs charge substantial tuition to cover the full cost of the program, some non-credit classes are subsidized through federal and state workforce grants—including Workforce Investment Act funds—which are often targeted to specific groups such as unemployed workers.

Although both the for-credit and non-credit case study programs tended to serve students with substantial work experience, the former were more likely to serve students changing careers whereas the latter were more likely to serve those already in the IT industry (see Table III.9). The average age of the for-credit and non-credit students was about the same (38 and 40, respectively) and was older than is typical for most community college programs.[68] In addition,

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[68]Nearly two-thirds (65 percent) of students in case study community college IT programs were age 30 years or older at the time of taking the IT class. In contrast, according to the National Profile of Community Colleges, less than one-third (32 percent) of all community college students are 30 years or older (Phillippe and Patton 2000).

TABLE III.9

CHARACTERISTICS OF CASE STUDY TWO-YEAR COLLEGE STUDENTS
WHO TOOK IT CERTIFICATION CLASSES[a]

	All	For-Credit	Non-Credit
Average Age	39	38	40
Average Number of Years Work Experience	18	17	18
Average Number of Years IT Work Experience	5	4	6
IT Work Experience (Percentage)			
0 years	27%	35%	18%
1–3 years	30%	32%	28%
4 or more years	43%	33%	54%
Percentage with Bachelor's or Advanced Degree	36%	28%	54%
Sample Size	**211**	**114**	**97**

Source: Case Study IT Student Survey, 2002, Princeton, N.J.: Mathematica Policy Research, Inc.

[a]At the time of the survey.

both groups of students had already accumulated substantial work experience (17 and 18 years, respectively). However, a substantially larger percentage of the non-credit students (54 percent) had four or more years of IT-related work experience at the time of the IT survey than was the case for the for-credit students (33 percent).

The non-credit students were also much more likely than the for-credit students to have four-year college degrees before they entered the IT class and, hence, were less likely to need a degree to achieve their career goals. More than half the for-credit students had a four-year degree, about twice the rate of non-credit students (see Table III.9). Because the non-credit students had higher levels of educational attainment and substantial IT experience, they were less likely to be interested in securing formal educational credentials: Only 17 percent of them said

they needed some additional educational degree to achieve their career goals compared with about 30 percent of the for-credit students. Non-credit and for-credit students were equally likely to say that they needed additional IT certificates to get the type of job they wanted.

Although most of the students in non-credit IT classes had a college degree, the survey findings suggest that some non-credit students are interested in earning credit toward a degree. Approximately 11 percent of the non-credit students reported needing to earn a two- or four-year college degree to get the job they planned to obtain within the next 10 years.[69] Some of these students might have preferred to take the certification classes for credit if they could have done so easily. The non-credit classes were often more convenient for students working in IT because these classes had more convenient schedules or accelerated pace. Apart from the scheduling differences, school staff members noted that some students preferred the non-credit classes because they did not want to complete the admission or assessment process or take required prerequisites. Colleges might consider the feasibility of making it easier for students to earn credit for taking IT classes that are similar to those currently offered in a non-credit format. This change might be done by modifying the schedules or formats of some for-credit classes, simplifying the admissions process or waiving some prerequisites for students with relevant IT work experience.

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[69]Another 6 percent of non-credit students indicated that they needed an advanced degree, but most of these students already had a bachelor's degree.

IV. CERTIFICATION, EDUCATION AND EMPLOYMENT OUTCOMES

Certification programs are designed to help students succeed in the IT field. Consistent with this ultimate goal, they typically seek to achieve several intermediate outcomes. Most programs are designed to help students prepare for IT certification exams. Recognizing that some students may not secure a certificate but still may be interested in pursuing careers in IT, most programs also seek to help participants develop useful IT-related skills, including those covered on the certification exam and other skills that employers value. Programs often prepare students

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KEY FINDINGS

- ***While most students do not secure certification, college students are more likely to secure it than high school students.*** Nationally, about 12 percent of those participating in the high school Cisco, Microsoft or Novell classes and 38 percent of community college class participants pass a certification test. Students may decide not to pursue certification because they lose interest in IT, have difficulty with the material or do not need the certificate to secure an IT job.

- ***Most case study students continued their IT studies after the certification class.*** After completing the certification class, most of the high school and college students in the case study schools took additional IT classes, and many entered another IT program. A substantial percentage of those entering new programs were able to use credits earned from their IT certification class toward a college certificate or degree.

- ***Many case study students obtained or stayed in IT jobs, and most of these jobs paid good wages.*** About 35 percent of the high school IT class participants and 64 percent of the college participants obtained or retained an IT job after completing the class. Most of both groups earned good wages. However, female students were less likely than males to obtain an IT job, and those who did received lower average wages.

- ***Programs might benefit from better follow-up information on student outcomes.*** Although the average student outcomes across all schools are fairly promising, some programs had lower outcomes. In addition, some schools have incomplete information on student outcomes because they do not routinely conduct follow-up surveys or use surveys with low response rates. Schools' ability to improve programs is likely to depend in part on their ability to determine how many and which students are successful. Educators might consider partnering with IT companies to secure more information on students' postprogram experiences.

for further education and training and sometimes allow them to earn credits accepted by other IT programs. Some programs help students find positions in the IT field. The main findings on the outcomes of students participating in certification classes are summarized in the following box titled Key Findings.

Examining the outcomes of students in certification programs, the focus of this chapter, can be helpful to educators in at least two ways. First, although student outcomes are not the same as program effects, they can provide a sense of the range of benefits generated by some programs. Measures of outcomes do not indicate what students would have done had they not participated in the IT program. Outcomes can, however, indicate the upper bounds of some program effects. For example, if only a small portion of participants earn a particular credential, then the effect of the program on students' success in securing that credential cannot be very large.

Second, school administrators, state officials and other funders need to review data on outcomes to gauge whether programs are achieving their stated objectives. Most case study programs had multiple objectives relating to student outcomes: They have sought to help students secure IT certificates, enter postsecondary IT programs and secure IT-related jobs. Regardless of whether a program is having some positive effect on students, if the average outcomes differ substantially from expectations, schools may need to modify the program's design, strengthen some aspect of how it is implemented or adjust their priorities.

With the exception of the certification data from the National IT School Staff Survey, the data on student outcomes come from the Case Study IT Student Survey and therefore pertain only to the case study sites. The student survey sample was selected from those taking certification classes toward the end of their high school and college programs, so they may have been somewhat more committed to IT than those who take only one IT class in their junior year

of high school or a single course in college.[70] All the students took certification classes in school year 1999–2000. Because the survey was conducted in spring 2002, it covers outcomes for the two years following most students' certification classes.

This chapter is organized around an analysis of four questions:

1. How many students take and pass IT certification exams?

2. Do students in the case study schools typically continue to pursue their interest in IT through additional education and training programs, and how many of these students are able to make use of credits earned in their certification classes?

3. Are students in the case study schools able to obtain IT-related jobs, and how much do these jobs pay?

4. To what extent are the case study schools able to obtain information on outcomes after students leave the IT program?

- ***Most students do not secure certification, but college students are more likely than high school students to do so.***

One of the original objectives of certification classes is to help students prepare for IT certification exams; however, whether participants actually take and pass tests depends on students' interests, abilities and perceptions of the value of certificates in the labor market. IT companies helped develop and promote certification classes based on the assumption that most students would want to try to secure one of the certificates. However, some students may decide they are not interested in a career in IT. Moreover, others may perceive that the certificates are not essential for the types of IT jobs they want.

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[70]The college sample represents those taking one of the last classes in the sequence of certification classes designed to prepare students for Cisco, Microsoft or Novell certification. Because substantial attrition often occurs in these programs, the college survey sample members are likely to have more focused IT interests or skills than college students who take only the first one or two classes in the sequence.

The National IT School Staff Survey and the Case Study IT Student Survey provide some information on students' success in getting IT certifications, but both data sources have strengths and weaknesses. The National IT School Staff Survey asked program staff members to report the number of students enrolled in Cisco, Microsoft and Novell classes during school year 2000–2001 and the portion of those students who passed at least one of these companies' certification tests. The sample for this survey is nationally representative; however, the school administrators responding to it may not have had complete information on participants' certification test experiences and success. In contrast, the Case Study IT Student Survey is not nationally representative; however, students probably have a more accurate sense of whether or not they secured a certificate than do program administrators. Fortunately, the two surveys provide consistent findings on the extent of certification.

Both surveys suggest that only a small portion of the high school students who take Cisco, Microsoft and Novell classes secure an IT certificate from one of the three companies. More than half (52 percent) of high schools responding to the National IT Staff Survey reported that none of the students in their IT classes secured a Cisco, Microsoft or Novell certificate. The average certification rate for all high schools was about 23 percent. The Case Study IT Student Survey also indicated that few students in the 10 case study high schools secured certificates: Only 12 percent of the high school students who responded to this survey reported securing one of the IT certificates for which their class was designed to prepare them. Another 5 percent subsequently obtained some other type of industry IT certificates (see Table IV.1).

High school students taking IT classes in vocational schools appear to be somewhat more likely to secure a certificate than students in other high schools, although small sample sizes limit the precision of these comparisons. About 61 percent of the 54 vocational schools responding to MPR's National IT School Staff Survey reported that at least some students secured an IT

TABLE IV.1

MAIN CERTIFICATION, EDUCATION AND EMPLOYMENT OUTCOMES OF CASE
STUDY HIGH SCHOOL STUDENTS AFTER TAKING IT CERTIFICATION CLASS

Outcome	Percentage
Ever Secured IT Industry Certificate After Certification Class	16
Secured certificate for which class was designed	12
Secured other certificate	5
Continued Education or Training After High School	75
Continued IT Education/Training After High School	56
Enrolled in IT college program	32
4-year degree	14
2-year degree	15
College certificate	3
Took IT classes but did not enroll in IT college program	24
Employed in an IT-Related Job After Certification Class	35
Retained IT-related job from before the class	1
Obtained IT-related job after class	34
Employed in an IT-Related Job or Continued IT Education/Training	68
Employed in an IT-Related Job and Continued IT Education/Training	31
Sample Size	**96**

certificate compared with only 42 percent of the 134 comprehensive high schools. However, this difference was not statistically significant. The Case Study IT School survey findings are consistent with those from the National IT School Staff Survey, with a larger portion of the vocational school students earning one of the certificates for which the IT class was designed to

prepare them. Again, however, small sample sizes limit the generalizability of these findings.[71] Students willing to travel to a vocational school may be more motivated to prepare for and take certification classes. Class periods in the case study vocational schools also tended to be longer than those of the comprehensive high schools. The longer classes allow students to cover the IT certification material in fewer semesters, perhaps reducing attrition.

The proportion of two-year college students who obtain a certificate is somewhat higher than that of high school students. The National IT School Staff Survey indicates that an average of 36 percent of students in for-credit college classes earned a Cisco, Microsoft or Novell certificate.[72] Although nearly all colleges (91 percent) reported that at least some students in these for-credit classes obtained a certificate, only 41 percent indicated that more than half their students secured one. One likely reason that colleges have higher certification rates than high schools is that high schools offer more complete sequences of certification classes and, in particular, are more likely to offer the last classes in these sequences.[73]

Among students in the case study colleges, those who had taken non-credit classes were more likely than those who participated in for-credit classes to obtain a certificate. More than half the students who took a certification class in the case study non-credit programs indicated that they had obtained one of the certificates related to their class compared with less than a third

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[71]A little more than a quarter of the 28 respondents to the Case Study IT Student Survey from the four vocational schools earned an IT certificate compared with only 6 percent of the students from the comprehensive high schools.

[72]The National IT School Staff Survey asked respondents only about certification rates among for-credit students. The survey did not ask for similar information about non-credit students.

[73]As noted in chapter II, colleges responding to the IT National School Staff Survey were more likely than high schools to offer all the classes needed to prepare for specific certifications. In addition, as one would expect, colleges with more complete programs of study tended to have higher certification rates.

of those who had taken a for-credit IT class (see Table IV.2). This difference in certification rates may be explained partly by the fact that non-credit classes in the case study colleges tended to follow closely an outline designed to prepare students for exams. For-credit classes tended to be broader and included more material not covered in the certification exams, reflecting IT departments' academic standards and degree requirements. The higher certification rates of non-credit students may also reflect their greater IT work experience and education (see chapter III).

The case study staff interviews and student surveys suggest that there are many reasons why students—both male and female—may choose not to take certification tests. Case study staff members noted that most certification tests are difficult to pass and that students have limited time to study for them. Some students decide they are not particularly interested in IT jobs. Among the respondents to the Case Study IT Student Survey, 40 percent of the high school class participants and 16 percent of college class participants reported that they no longer expected to pursue a career in an IT field. Finally, some students believe that certification is not particularly useful in getting IT jobs. Among college students who worked in the IT field after their IT class, 48 percent reported that their employer did not give any preference in hiring to employees who had an IT certificate. About 56 percent said that an IT certificate was not needed to get a better job or advance faster in their current jobs. Although students with a certificate were more likely to get an IT-related job, many students got this type of job without one.[74]

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[74]We address this issue below in the section on students' postprogram employment outcomes.

TABLE IV.2

MAIN CERTIFICATION, EDUCATION AND EMPLOYMENT OUTCOMES OF CASE STUDY
TWO-YEAR COLLEGE STUDENTS AFTER TAKING IT CERTIFICATION CLASS

Outcome	All	For-Credit	Non-Credit
Ever Secured IT Industry Certificate After Certification Class	50	45	61
Secured certificate for which class was designed	38	31	52
Secured other certificate	27	21	37
Completed College Program or Continued Education or Training	81	86	74
Completed IT College Program or Continued IT Education/Training	78	82	69
Completed IT college program that included certification class[a]	27	39	3
4-year degree	1	2	0
2-year degree	20	30	0
College certificate	6	6	3
Continued IT education/training	73	75	67
Enrolled in an IT postsecondary program after certification class[a]	23	25	18
Master's degree	1	1	1
4-year degree	7	8	5
2-year degree	7	9	3
College certificate	8	7	9
Took IT classes after certification class but did not enroll in an IT postsecondary program	50	50	49
Employed in an IT-Related Job After Certification Class	64	60	71
Retained IT-related job from before the class	25	22	31
Obtained IT-related job after class	39	38	40
Employed in an IT-Related Job or Continued IT Education/Training	86	86	85
Employed in an IT-Related Job and Continued IT Education/Training	51	50	54
Sample Size	**211**	**114**	**97**

Source: Case Study IT Student Survey, 2002, Mathematica Policy Research, Inc.

[a]Some respondents had more than one of these outcomes.

Low certification rates led some members of case study school staff to reconsider program priorities, although other members of the staff continued to emphasize certification as a desirable outcome. Some staff members said they had begun to de-emphasize the goal of certification while continuing to prepare students for IT jobs and postsecondary programs. Other case study programs, particularly those in high schools, were considering ways to revise their student screening procedures or class prerequisites, seeking to attract more students who were likely to take and pass certification tests. Still other schools with low certification rates chose to retain the certification goal without modifying the design of their programs.

Low certification rates are likely to continue to pose a dilemma for some schools in the future. Programs with low certification rates could choose to de-emphasize this objective. However, this choice could undercut the motivation of some students to take the class or to work hard at acquiring valuable IT skills. Alternatively, schools could continue to emphasize certification as a central goal. However, this approach risks alienating key constituencies—students, school administrators, employer partners—assuming certification rates remain low. To ensure that these constituencies' expectations are realistic, program staff members could reduce the importance they place on certification while retaining it as one of many program objectives.

- ***Most case study students continued their IT studies after completing the certification class.***

IT certification classes could help further students' career goals by helping them prepare for further education or training. Even if participants do not secure a certificate, the classes may confirm students' interest in the IT field and their desire to pursue additional IT-related postsecondary programs. Certification classes may also help students develop skills useful in other education and training programs. Some high school and community college IT classes provide credits that count toward degrees or certificates at other schools.

The key findings on education outcomes are based largely on the case study IT Student Survey questions about respondents' status after completing the IT certification class. The survey includes questions about whether respondents completed the IT program that included the IT certification class. The survey also asked respondents whether, after completing the certification class, they entered any education or training programs and, if so, whether these programs were "designed to prepare students for careers in the IT field" (referred to as an "IT program" in the following discussion).[75] Students were also asked whether they took any types of IT classes after the certification class. Table IV.1 summarizes the education and training outcomes of the high school participants, and Table IV.2 shows the outcomes of the for-credit and non-credit college class participants.

Most of the case study students who had taken a high school certification class participated in some IT program or class after high school. Within two years of leaving high school, three-quarters of the students participated in some type of education or training program or class—about 48 percent enrolled in two-year or four-year colleges, and 27 percent participated in other types of programs or classes. More than half (56 percent) participated in an IT-related education or training program or class. About 32 percent participated in an IT college program, and another 24 percent took some IT classes outside of a college program.

Similarly, most of those participating in the community college continued their IT studies. Within two years of completing the certification class—which was the last in a sequence of college classes designed to prepare students for certification tests—73 percent said they either enrolled in another IT postsecondary program (23 percent) or took some additional IT classes (50

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[75]Respondents were told that the "IT field" refers to "jobs involving tasks like network administration, Website development, programming or technical support" and excludes "jobs where people use computers for tasks such as word-processing or data entry."

percent). When students said they enrolled in an IT postsecondary program, typically this program was in a college: a two-year or four-year degree program or a college certificate program (see Table IV.2).

Although it is difficult to tell how many of these students would have continued their IT education in the absence of the certification class, the case study students suggested that the class helped them prepare for other IT programs. Close to half the case study student survey respondents reported that the certification class was very helpful in preparing for additional education or training.[76] In fact, the students were more likely to say the class was very helpful in this respect than in preparing them for IT jobs (see Table IV.3). The large number reporting that the class was very helpful in preparing for other programs suggests that students probably developed skills that they thought they could use or did use in other IT programs and classes. In addition, nearly 40 percent of the students reported that the class was very helpful in clarifying their career goals. By confirming their interest in specific kinds of IT careers, the class may have helped them decide to continue their IT studies or helped them select specific IT education or training programs.

Another concrete way the class was helpful to some who continued their studies in IT was by providing course credits that could be used in other postsecondary programs, particularly college programs. About a quarter of those who entered an IT-related postsecondary program after taking a high school certification class reported that they were able to use credit from that class toward the postsecondary program's degree or credential. By contrast a considerably smaller fraction of postsecondary students who took other vocational classes in high school

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[76]Over 80 percent reported that the class was very or somewhat helpful in preparing for additional education or training and helpful in clarifying their career goals.

TABLE IV.3

PERCENTAGE OF CASE STUDY STUDENTS REPORTING THAT THE IT
CERTIFICATION CLASS WAS VERY HELPFUL IN SPECIFIC WAYS

Criteria for Assessing Class	Participants' Certification Program			
	High School	College All	College For-credit	College Non-credit
Developing Skills Needed for a Job	38	48	47	50
Preparing for the Type of Job Wanted in the Future	34	41	42	40
Clarifying Career Goals or Type of Job Desired	42	36	37	33
Preparing for Additional Education or Training	46	52	56	46
Sample Size	**96**	**211**	**114**	**97**

Source: Case Study IT Student Survey, 2002, Princeton, N.J.: Mathematica Policy Research, Inc.

receive any postsecondary credit for those high school classes.[77] Nonetheless, the fact that three quarters of high school students enrolling in colleges did not secure any credit from their certification class highlights the potential value of expanding articulation agreements so high school certification credits are more portable.

Community college students also secured credit at other postsecondary programs for their IT certification class. Among students who took a community college IT certification class and subsequently entered a postsecondary degree or institutional credential program in IT, 40 percent

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[77]For example, another recent survey of students in the Class of 2000 in eight states found that only 8 percent of all students with a vocational concentration who were enrolled in postsecondary programs received some college credit for a vocational class they took in high school (Haimson and Deke 2003).

said that they received credits from their IT class toward that program's postsecondary degree or other credential. As would be expected, among those entering a degree or college certificate program, a larger percentage of the for-credit class participants (48 percent) than the non-credit participants (20 percent) made use of the certification class credits. However, the fact that some non-credit participants were able to secure some credit for the certification class suggests that some schools may now recognize that many non-credit IT classes cover the same curriculum as for-credit classes.[78]

Many college class participants who entered other IT postsecondary programs received tuition subsidies from their employers.[79] Some recent studies suggest that difficulty paying for postsecondary education is one of the most common reasons for dropping out (Haimson and Deke 2003). About 41 percent of the college class participants who entered a postsecondary IT program reported that their employer helped pay for it, which suggests that some employers value the skills that these classes develop.[80] It also suggests that those interested in continuing their studies in IT can benefit if they secure a job with one of these employers.

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[78]One must be cautious in interpreting these results because the sample of non-credit students entering other programs is small ($n = 20$).

[79]More non-credit students (57 percent) than for-credit students (33 percent) reported that their employer paid for their postsecondary program.

[80]However, few students in the case study high school sample (8 percent) received any tuition reimbursement from employers. This difference is probably partly because of the fact that college participants had accumulated substantially more IT work experience than those participating in the high school classes. As noted in chapter III, on average, the college students had accumulated about five years of full-time IT work experience. In addition, among college students, those with five or more years of IT work experience were much more likely to receive some employer support (55 percent) toward their postsecondary program than those with less than five years of related experience (48 percent).

- *A substantial portion of case study students entered or stayed in IT jobs that pay good wages.*

Ultimately, the goal of IT certification classes is to help students pursue careers in the IT field. These classes may help students obtain IT jobs or advance within the field by helping them secure certifications or other educational credentials. Certification classes can also help students clarify their interests and goals, develop skills that employers value and find specific IT positions. With the recent downturn in the IT sector and the subsequent layoffs in many firms, certification classes could have helped even students who remained in the same position if they had developed skills they needed to keep their jobs.

The Case Study IT Student Survey included several questions about the jobs respondents held or obtained after the beginning of the IT certification class. The survey asked students details about their most recent job and whether that or any other job they held "primarily involved information technology tasks" (referred to in the following discussion as an "IT-related" job).[81]

A substantial percentage of the case study high school students and most of the college students were employed in IT-related jobs after the certification class. About 35 percent of the high school participants reported that they were employed in an IT-related job after their certification class, and nearly all these students obtained their position after the class ended.[82] Slightly less than two-thirds of the college participants were employed in IT positions after the

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[81]The probe in the survey defined information technology tasks as those that include "network administration, Web site development, programming, or technical support." The survey asked only about jobs that started after September 1999, the first month that the certification classes could have started.

[82]About 34 percent obtained an IT position, and 1 percent retained a position that they had held before the class started.

class, although some of these students retained an old IT job: About 25 percent of the college participants retained an IT job that had begun before the class started, and 39 percent obtained an IT job after the class started. The large percentage of college students who reported retaining a job in IT reflects the fact that many of them already had substantial IT work experience.[83]

The percentage of college students who obtained IT-related jobs varied substantially among the case study schools. In the case study colleges, the percentage of students who obtained an IT job ranged from about 50 percent to 88 percent.[84] Moreover, the variation in students' average employment outcomes did not appear to be explained by students' IT or other work experience, which suggests that some schools' certification programs may be more effective than others.

Although those with IT certificates were more likely to hold IT jobs, many case study high school and college students who had no certificate succeeded in obtaining some IT-related position. Among those who did not have any IT certification, about 30 percent of the high school class participants and 53 percent of the college participants obtained or retained an IT position after the class started. These rates are substantial and are consistent with student reports that most employers did not require a certificate to secure a job. Nonetheless, an even larger percentage of those with certificates were employed in IT positions (58 percent of the high school participants and 73 percent of the college participants with certificates). This relatively high rate of

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[83]At the time of the survey, college students had, on average, six years of IT work experience. This measure includes work from both before and after the IT class. At least 41 percent of college students had IT work experience from before the IT class because they reported having more than three years of IT work experience and because nearly all started the IT classes less than three years before the survey.

[84]The high school samples were too small to permit examination of average outcomes by school.

employment in IT jobs may reflect not only the value of a certificate but also the greater interest, motivation or skills of those with certificates.[85]

Among case study high school and college students who obtained IT-related jobs, a modest portion found their jobs with help from school staff members. Of high school students who were employed in an IT job after the certification class, about 21 percent reported that school staff members helped them "find or get" that job. A somewhat smaller percentage of the college students (13 percent) reported that school staff members helped them find or get their jobs.[86] Interviews with staff members indicate that this job placement assistance was more likely to have come from informal contacts between instructors and students than from formal job placement or internships programs.

Some students continued to be interested in IT careers but did not find any IT jobs after their certification class. Among those still interested in IT careers, about 29 percent of high school participants and 24 percent of college participants had not secured any IT-related job during the approximately two-and-a-half-year follow-up period covered by the Case Study IT Student Survey. This finding points to the potential room for improvement in IT programs' efforts to place students in jobs and internships.

On average, case study students' IT-related jobs paid good wages. The overall average wage earned by students who participated in the high school certification classes was $9.78 an hour (see Table IV.4). Those who worked in IT-related jobs had higher average wages ($11.47) than those in jobs unrelated to IT ($8.75). Nationally, the average wage of workers of a similar age is

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[85]Indeed, many of those without IT certificates (40 percent among high school students and 26 percent among college students) said they were no longer interested in IT careers.

[86]Students from for-credit programs were more likely to have been helped by school staff members in finding a job (17 percent) than those in non-credit programs (7 percent), who may have been more likely already to be employed in an IT-related job.

TABLE IV.4

AVERAGE WAGES OF EMPLOYED CASE STUDY STUDENTS AFTER
COMPLETING IT CERTIFICATION CLASS[a]

	Average Wage	Median Wage	Sample Size
High School Certification Class Participants			
All Jobs	9.78	8.50	90
IT-Related Jobs	11.47	9.60	34
Other Jobs	8.75	7.77	56
College Certification Class Participants			
All Jobs	18.79	16.83	173
IT-Related Jobs	19.29	17.31	122
Had more than 3 years IT work experience[b]	23.26	21.15	62
Had 3 years or less IT work experience[b]	15.34	14.96	59
Other Jobs	17.70	16.83	51
For-Credit College Certification Class Participants	16.60	16.03	90
Non-Credit College Certification Class Participants	22.74	20.38	83

Source: Case Study IT Student Survey 2002, Mathematica Policy Research, Inc.

[a]All of the wages are for respondents' most recent IT job or their most recent job if they did not work in IT.

[b]Groups defined by the amount of IT work experience at the time of the survey.

somewhat lower than the overall average wage of the high school IT participants and substantially lower than the average for those securing IT-related jobs.[87]

Community college students who obtained or stayed in IT-related jobs also made good average wages ($19.29 an hour). These wages are roughly comparable with national estimates of wages in the types of IT jobs for which students received training.[88] Wage estimates published by IT vendors and IT magazines, though based on surveys with low response rates, are also fairly close to the average wages reported by case study college participants who found IT jobs.[89]

The case study college student survey data suggest that the most important driver of average wages is the number of years participants had worked in IT-related jobs, an indication of the high value employers place on experience. For example, college participants with three years or more of IT work experience earned an average wage of $23.26 compared with only $15.34 for those with less than three years of IT work experience. Estimates from multivariate regression analyses of the case study students' wages indicates that the number of years of IT work experience is the

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[87]In spring 2002 when the Case Study IT Student Survey was conducted, the respondents' ages ranged from 18 to 22 years, with an average age of 20. According to the Current Population Survey (CPS) conducted in the first quarter of 2002, employed 16- to 19-year-olds earned an average of $7.10 an hour and 20- to 24-year-olds earned $9.19 an hour. Even this group, who on average are probably about two years older than the case study students, earned substantially lower average wages than the case study students in IT jobs. (These estimates are based on unpublished CPS tables obtained from the Bureau of Labor Statistics.)

[88]For example, according to the Bureau of Labor Statistics 2000 wage surveys, computer support specialists had an average hourly wage of $19.08, and network and computer systems administrators had an average hourly wage of $25.81. Of course, these IT professionals may or may not have IT certifications, and their average education and work experience may differ from those of case study students.

[89]For example, according to *Certification Magazine*'s 2002 Salary Survey, IT workers with certificates and less than 3 years of IT work experience earned $18.65 an hour, and those with certificates and 3 to 5 years of IT work experience earned $25.47 an hour (*Certification Magazine* 2002). Both *Microsoft Certified Professional Magazine* and TCPmag.com (which pertains to Cisco programs and certifications) report similar salary ranges in their 2002 salary surveys (*Microsoft Certified Professional Magazine* 2002; TCPmag.com 2002).

strongest predictor of average wages and that it is more important than education, certification or other variables.[90]

The average wages of those with an IT certificate were somewhat higher than those without IT certificates. Overall among the community college participants employed in IT jobs, the difference in the average wage of those with and without a certificate was $3.88 (see Table IV.5). Although other factors such as work experience and education contribute substantially to average wages, the estimated increase in wages associated with securing a certificate does not change appreciably even after controlling for these and other factors.[91] However, these results should be interpreted with caution. Those who chose to obtain certification may have been more interested in IT or may have had other assets that we were unable to observe but that might have led them to earn higher wages even in the absence of a certification. Moreover, these estimates are based on small samples, which makes it harder to estimate precisely the wage premium associated with securing an IT certificate.

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[90]This finding is based on estimates from Ordinary Least Squares regressions on wages of those in IT jobs, controlling for whether students had secured an IT certificate, how many IT classes they had taken, whether they had a bachelor's degree, whether they had an associate's degree, how many years of IT work experience, how many years of other work experience, which gender, and what race. Years of IT work experience is the only variable that is statistically significant (with a p value smaller than .05). Similarly, IT work experience is the only consistently significant predictor of wages in regressions on wages of all employed students (including both those with IT jobs and other jobs).

[91]The regression described in footnote 24 indicated that the difference in wages associated with having an IT certificate was about $3.50 (this difference is the coefficient on the IT certificate indicator variable). However, perhaps because of limited sample sizes, this coefficient was not statistically significant, which suggests that the hypothesis that the premium is zero cannot be rejected.

TABLE IV.5

AVERAGE WAGES, BY IT CERTIFICATION AND EDUCATION OF
CASE STUDY TWO-YEAR COLLEGE STUDENTS

	All	With IT Certificate	Without IT Certificate	Difference With and Without IT Certificate
All Jobs	18.79	19.89	17.30	2.59
At least Bachelor's degree	22.34	22.69	21.86	.83
Without Bachelor's degree	16.71	18.21	14.71	3.50
IT Jobs	19.29	20.72	16.84	3.88
At least Bachelor's degree	21.98	22.69	20.66	2.03
Without Bachelor's degree	17.37	19.71	13.93	5.78

Source: Case Study IT Student Survey 2002, Princeton, N.J.: Mathematica Policy
Research, Inc.

There are some signs that any wage differential associated with holding an IT certificate
may be larger for those who do not have a four-year college degree. Among the college class
participants who did not have a bachelor's degree, the difference between the average wage of
those with and without a certificate was $5.78, considerably more than the average certification
wage differential for students with a bachelor's degree (see Table IV.5).[92] Even after one
controls for IT work experience and other observable characteristics of students, those without a

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[92]Similarly, among all employed case study college participants (including those in non-IT
jobs), the wage premium associated with a certificate is largest for those without a bachelor's
degree (see Table IV.5).

bachelor's degree appeared to secure a somewhat higher return from securing a certificate.[93] Again, one must be careful in interpreting this result because we may have not observed all the personal assets of those with and without certificates and bachelor's degrees.[94]

Overall, the IT certification case study programs appear to have promising outcomes. The vast majority of both high school and college case study participants either continued their studies in IT or secured IT-related jobs. It is not clear how students' IT certification classes affected their outcomes because some might have pursued a similar path even in the absence of the class. In addition, the case study programs may not be representative of all certification programs in high schools and colleges. Nonetheless, these results suggest that the potential upper bounds of the effect of the case study programs on students' employment and education outcomes is substantial. However, average certification and employment outcomes of students appear to vary substantially across schools, suggesting that schools may need to collect some follow-up information to determine whether their programs are achieving specific objectives.

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[93]This finding is based on estimates from various Ordinary Least Squares regression models, including those limited to people employed in IT and those covering all jobs. These models included an interaction term equal to 1 for those having both a bachelor's degree and an industry certificate. In addition, the regressions controlled for whether students had secured an IT certificate, number of IT classes taken, whether they had a bachelor's degree, whether they had an associate's degree, years of IT work experience, years of other work experience, gender, and race. Although the coefficients on the interaction terms were statistically insignificant, they were consistently negative. In the model estimated on all jobs, the value of the interaction term was –5.50, which suggests that the wage premium for a certificate was $5.50 smaller for those with a bachelor's degree than the premium for a certificate for those without a college degree. In the model that was estimated just with the sample with IT jobs, the interaction term was –2.23. This finding suggests that about half the differential between the certificate premiums reaped by those with and without a bachelor's degree is related to getting a job in IT and the other half is related to advancing within IT.

[94]For example, those with four-year degrees who did not secure a certificate may have been more qualified in unobserved ways than those with four-year degrees who obtained a certificate, which would reduce the estimated certification premium for the group.

- *Female case study students were less likely than males to obtain certificates, continue their studies in IT, and secure IT jobs.*

Females are underrepresented in the IT industry, but the reasons for this phenomenon remain unclear. As noted in chapter III, certification classes tend to attract more males than females. Program staff members suggest that gender-based stereotypes and differences in learning styles seem to discourage some females who articulate interest in IT classes and careers. To get a more complete picture of the factors that may discourage female students from pursuing a career in IT, we now examine the extent to which female students participating in the case study programs secured IT certifications and entered IT related jobs. One must be cautious in interpreting these findings because the number of female respondents is small.[95]

Female case study students were less likely than males to obtain an IT certificate. Only 5 percent of female high school participants secured one of the certificates for which their class was designed compared with 14 percent of the males. Similarly, among the case study college students, only 25 percent of females obtained a certificate compared with 44 percent of males. Although female students were less likely than males to take certification exams, female and male test takers were about equally likely to pass if they took a test.[96] Female participants may be less interested in pursuing the careers for which certificates are designed or they may perceive obstacles to getting those types of jobs. A larger percentage of female participants (23 percent) than males (14 percent) reported that, in about five years, they did not expect to work in the IT

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[95]Only 21 female participants in high school certification classes responded to the Case Study IT Student Survey. The sample size for female college participants is also limited, though somewhat larger ($n = 57$).

[96]Only 28 percent of female participants took a certification exam compared with 48 percent of males.

field. However, even among those expecting to work in IT, females were less likely than their male peers to earn a certificate.[97]

Female case study students were also less likely than males to pursue additional IT-related education and training after the certification class. Among high school students, only 18 percent of females enrolled in IT college certificate or IT degree programs compared with 36 percent of males; similar percentages of females (27 percent) and males (23 percent) enrolled in other types of IT classes.[98] Among college students, a comparable percentage of females (24 percent) and males (21 percent) enrolled in IT college certificate or IT degree programs; however fewer college female students (42 percent) than males (54 percent) entered other types of IT classes (outside college certificate or degree programs).[99]

Female participants in both the case study high school and community college classes were less likely than their male peers to secure IT jobs. Among the high school students, only about 22 percent of the females obtained an IT job compared with 40 percent of males. Among the

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[97]Among those expecting to work in IT in 10 years, a smaller percentage of female participants (30 percent) than male participants (47 percent) secured an IT certificate. As will be discussed in the following text, female case study students were also less likely than males to obtain IT-related jobs after completing the class. Along with the relatively low female rates of participation in IT certification classes, these findings suggest that some experiences discourage females from pursuing careers in the IT field or encourage them to pursue other careers.

[98]Overall, a percentage of male high school participants (77 percent) that was somewhat larger than female participants (68 percent) entered some form of postsecondary education or training. This finding suggests that the female students in the case study high school programs may be different from those female students nationally who now enroll in postsecondary programs at higher rates than males.

[99]Overall, about the same percentage of female college participants (66 percent) and male college participants (67 percent) entered some type of postsecondary program; however, a larger percentage of females (10 percent) than males (2 percent) enrolled in non-IT degree programs. At the time of the survey, the females who participated in the two-year college certification classes were about equally likely to hold at least a bachelors and more likely than males to hold a two-year college degree.

students who participated in the college programs, only 55 percent of the women reported that they secured jobs in the IT field after their certification class compared with 68 percent of the male participants.[100] Even among those who reported that they ultimately expected to have a career in IT, fewer women secured or retained IT-related positions (63 percent) than men (76 percent).

Among the college class participants who did secure IT-related jobs, women had lower average wages ($15.89) than men ($20.61). Regression estimates suggest that much of this gender gap in average wages can be explained by the fact that female participants had less IT work experience and were less likely to have certificates during the follow-up period. Nonetheless if women observe this gender gap in wages in conjunction with lower rates of female participation in IT classes and lower rates of IT employment among those who participated, it may further discourage them from entering the field.[101]

Educators and IT companies should explore more carefully the reasons that female students are less likely than males to pursue a career in IT. Gender-based stereotypes may lead some females to pursue other careers. In addition, it is possible that females are discouraged by the

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[100]Males and females were equally likely to retain an IT-related job from before the class (24 percent and 25 percent, respectively), but males were more likely to obtain an IT-related job after the class (42 percent and 31 percent, respectively).

[101]We estimated regressions on wages that controlled for whether students had secured an IT certificate, number of IT classes taken, whether they had a bachelors degree, whether they had an associates degree, years of IT work experience, years of other work experience, race, and whether the participant was female. We introduced the control variables sequentially to determine which ones reduced the negative coefficient on the female indicator, in effect explaining the gender gap in wages. The two variables that explained the largest portion of the gender gap in wages were IT work experience and IT certificates. We estimated these regressions both for students employed in IT and for all employed students. For the regressions estimated on IT jobs, the coefficient on the female indicator was only –0.5, suggesting that the other control variables explained most of the gender gap in wages. For the regressions estimated

lack of successful female role models in IT. To determine how to attract more women to IT, educational researchers might conduct more surveys with females who are interested in IT careers, including both those who have been successful and those who have not.[102] These types of surveys may reveal the experiences that lead some females to exit IT and those that help others succeed in the field.

- *Programs need better follow-up information to support continuous improvement.*

Information on the outcomes of students in a school's career-focused programs can be helpful to program staff members and others. Programs can benefit by obtaining updated information on the range of career paths that graduates pursue so they can help other students identify local employment and educational options. To gauge the extent to which they are achieving specific program objectives, staff members need some information on student outcomes. If specific objectives are not being achieved, staff members may need to modify the program design, program objectives, or both. Information on a school's average student outcomes may also help identify promising programs. Although more extensive effect studies may be needed to confirm that promising program models are effective, tracking average student outcomes is a useful first step.

Many case study schools had incomplete information on student outcomes because they had difficulty staying in touch with students. Although instructors in nearly all the case study schools

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(continued)
on all jobs, the coefficient on the female indicator was –3.5, suggesting that some of the gender gap in wages could not be explained.

[102]As noted in chapter III, some IT companies such as Cisco have sought to identify and promote program strategies to recruit and support female students, including efforts to involve female role models and mentors.

were familiar with the outcomes of some of their students, they did not have the time or resources to collect information systematically on all students. Only about half the case study schools reported that school staff members regularly conducted surveys of program completers to track their outcomes. Moreover, some of the schools that conducted follow-up surveys did not have sufficient staff members or resources to ensure a high survey response rate.[103]

Schools that support students' job search or certification efforts sometimes are in a better position to track students. For example, schools in which instructors play a larger role in helping students find jobs are better able to identify students' employment outcomes. Similarly, schools that offer to pay for students' certification tests are more likely to find out whether students take and pass these tests.[104] However, because some students do not want much help from schools, even schools offering job placement and test subsidies can have difficulty finding out about the outcomes of some students. Moreover, unless graduates choose to stay in touch with schools, staff members will have difficulty tracking students' longer-term outcomes.

Although federal Perkins legislation encourages states to track all postsecondary credentials, most states do not have the capacity to track certification. Perkins indicates that states should measure the extent to which vocational class participants acquire a "proficiency credential" or "postsecondary degree or credential." Although the legislation does not define these terms, a few states interpret them broadly to include any institutional or industry credential or skill

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[103]Only three schools were able to provide information on their typical response rates for follow-up surveys of students. In two schools, only about half those surveyed usually responded. In the third school, about 75 percent of sample members responded.

[104]Although IT vendors maintain databases on which students secure certificates, these databases are not organized by school and generally contain no information on students who have taken a test but failed it. Moreover, because IT vendors treat these data as confidential, they will not release them to schools, which makes it harder for staff members to track their students' certification rates.

certificate. However, because many schools have difficulty accurately tracking industry certificates (such as those issued by Cisco, Microsoft and Novell), most states are able to report only the percentage of vocational students who earn high school and college degrees or college certificates—in effect underestimating the portion of participants who earn some credential. The potential extent of this problem is highlighted by the credentials that the participants in the case study college programs earn. About 55 percent of the case study college students earned some type of credential—a degree, college certificate or industry certificate (see Table IV.6). About half this group received only an industry IT certificate and no degree or college certificate. Therefore, schools and states that are unable to identify students who earn industry certificates may substantially underestimate the number earning some credential.

IT companies might explore ways to help schools measure and improve student outcomes. For example, schools could ask all students who enter their IT programs to sign a release that allows IT companies to divulge information on which students pass certification exams and any employment or educational information collected in company surveys of certificate holders. Student releases could also be designed to allow schools and certification companies to share their most recent contact information and e-mail addresses for students, thereby enhancing the response rate on any follow-up surveys. Schools could offer to pay for certification tests for any student signing this type of release, increasing the incentives for both students and certification companies to share information on student outcomes. Alternatively, certification companies might provide schools with some aggregate statistics that show how many of their students took and passed certification tests, without revealing the outcomes of individual students. Certification companies might also provide schools or states with some outcomes broken down

TABLE IV.6

EDUCATION AND INDUSTRY CREDENTIALS EARNED, BY OUTCOMES OF
CASE STUDY TWO-YEAR COLLEGE STUDENTS

	All	For-credit	Non-credit
Obtained Any Credential for Which IT Class Was Designed to Prepare Students	55	56	53
Obtained college certificate or degree, but not industry IT certificate	17	24	1
Obtained industry IT certificate, but not college certificate or degree	27	16	50
Obtained both industry IT certificate and college certificate or degree	11	15	2
Sample Size	**211**	**114**	**97**

Source: Case Study IT Student Survey, 2002, Princeton, N.J.: Mathematica Policy Research, Inc.

by gender and perhaps race so they could determine whether specific groups of students have been more successful than others.

The future of certification programs and other vocational programs depends in part on better documentation of how they contribute to students' success in careers. Many policy-makers continue to ask for convincing evidence of the value of occupationally focused programs, particularly in high schools. Efforts to improve programs are contingent on a better understanding of students' postprogram experiences. By working more closely with certification companies and other partners, schools can collect better information on students' experiences and use it to help more students succeed.

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