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Executive Summary

Since the mid-1990s, the Pennsylvania Department of Education (PDE) has required all students concentrating in career and technical education (CTE) programs to complete a standardized technical skill assessment at or near the end of their program. Results of technical skill assessments are used for a number of purposes, including recognizing student achievement, supporting program improvement and professional development efforts, and holding educators accountable for their students' performance. Interest in such assessments and their use are increasing nationwide, particularly in response to the 2006 Perkins Act requirement for reporting on career and technical skill proficiencies (Hyslop, 2009). Research, however, has yet to fully relate technical skill levels, as measured by high school graduates' performance on broad work readiness or narrow, occupation-specific technical skill assessments, to their subsequent employment and/or postsecondary enrollment outcomes.

To address this gap in the literature, this study analyzes data on over 21,500 high school graduates with a CTE concentration in Pennsylvania who completed a workplace readiness or occupation-specific assessment developed by the National Occupational Competency Testing Institute (NOCTI). To control for student demographic characteristics and educational experiences, assessment score record data for the 2005–2006 and 2006–2007 academic years were merged with student-level administrative records maintained by the Bureau of Career and Technical Education, PDE. Follow-up data on graduates' post-program work experiences were obtained from a state survey administered to all CTE program graduates to ascertain their job status in the second quarter following their high school completion. Postsecondary enrollment data were obtained by matching student identifiers with records maintained by the National Student Clearinghouse (NSC) to determine whether individuals enrolled in a postsecondary institution at any time between completing high school and the fall of 2009.

Descriptive statistics identify the demographic, high school academic, and CTE program characteristics of graduates who took workplace readiness and occupation-specific technical skill assessments and show graduates who had earned industry certifications by program type and skill level. The second half of the analysis estimates logistic regression models of the effect of technical skill level (as measured by a technical skill assessment or industry-recognized certification) on the odds of postsecondary enrollment following high school graduation.

Although Pennsylvania is one of the most advanced states in administering technical assessments to all secondary CTE program graduates, associating test performance with post-program placements is compromised by low response rates. Of the nearly 30,000 graduates for whom NOCTI test scores were available, researchers were able to match educational records for just over 21,500 individuals (72%). Of these, researchers were able to identify self-reported employment outcomes for nearly 6,100 (29%) and postsecondary enrollment outcomes for roughly 8,800 (41%) CTE graduates. Missing data were greatest for students scoring at the lowest level of the technical assessments.

Among the graduates for whom record matches were achieved, descriptive statistics indicate positive associations between graduates' technical skill level as measured by a technical skill assessment, being female, and enrolling in a Health Occupations or Occupational Home Economics program. Skill levels also are positively associated with graduates' grade point average (GPA) and the number of advanced math and science courses passed.[1]

Multivariate analyses indicate that, when controlling for race/ethnicity, gender, the number of advanced science and math courses passed during high school, and GPA, the odds of CTE program graduates enrolling in higher education are greater by a factor of 1.39 for those with the highest level of technical skill than those with the lowest level, as measured by performance on an occupation-specific assessment. Among CTE graduates who took a workplace readiness assessment, the odds of enrolling in postsecondary education among those scoring at the highest skill level are greater by a factor of 2.22 than those scoring at the lowest skill level. Although data on industry-recognized certifications were more limited, no statistically significant relationship was found between earning a certification and enrolling in higher education.

[1] Comparisons reported in the text were tested using Pearson's chi-square test for independence and are significant at the $p < .05$ level.

The Carl D. Perkins Career and Technical Education Improvement Act of 2006 (Perkins IV) mandates that states report on the technical skill attainment of students concentrating in career and technical education (CTE) using assessments aligned with industry-recognized standards, where available and appropriate.[2] States use a variety of instruments to assess students' technical skill attainment, including district- and state-developed assessments, standardized exams developed by public and private vendors, credentialing or certification exams developed by industry associations, or some combination of these approaches (U.S. Department of Education, 2008). States also use proxies for concentrators' attainment of technical skills, including grade point average (GPA) in technical courses or completion of a CTE program sequence (Government Accountability Office [GAO], 2009).

Of the 34 states using one or more technical assessments to meet Perkins IV accountability requirements in the 2006–2007 program year, the most commonly identified were associated with industry-developed certificates or credentials (32 states), followed by nationally developed exams (29 states; U.S. Department of Education, 2008). Among states using nationally developed assessments not associated with an industry-developed certificate or credential, many contract with the National Occupational Competency Testing Institute (NOCTI), a non-profit corporation governed by a consortium of states; NOCTI provides standardized technical skill assessment development and scoring.

Advocates for the use of technical skill assessments in CTE programs contend that testing will lead to educational improvements by clarifying instructional goals, raising performance expectations, and motivating students to achieve high-level standards (Bishop, 2002). Technical skills assessments also are envisioned to give state and local education agencies the information staff need to gauge program effectiveness and to direct assistance to programs that are performing inadequately (U.S. Congress Office of Technology Assessment, 1994). However, the usefulness of technical skills assessments for these purposes depends in part on whether the assessments indicate the attainment of desirable postsecondary outcomes. If students' technical skill levels (as measured by technical skill assessments) are positively associated with post-program results, such as rates of employment, job performance and earnings, postsecondary enrollment, and degree completion, then program improvements might be directed to enhancing students' skill acquisition.

Background and Literature Review

Technical Skills Assessments

Over the past two decades, federal CTE policy has directed states to adopt strategies for tracking student attainment of technical skills. Although states retain considerable flexibility in how they assess concentrators' technical skills, the U.S. Department of

[2] A concentrator is a student who completes a threshold level of CTE program coursework. In Pennsylvania, a secondary CTE concentrator is a student who, by the end of the reporting school year, has earned at least 50% of the minimum technical instructional hours required for PDE program approval.

Education, Office of Vocational and Adult Education (OVAE), has sought to narrow states' reporting options. Non-regulatory guidance—released by OVAE to assist states in designing measures for the Perkins IV 2006 reauthorization—calls for states to use technical skill assessments aligned with industry-recognized standards, where available and appropriate, to measure CTE concentrators' skill attainment (U.S. Department of Education, 2007). States lacking such assessments are directed to report on the estimated percentage of students included in the measure and their plan and timeframe for increasing program and student coverage. Despite these recommendations, many states have expressed preferences for the use of indirect measures of technical skills, such as GPA or program completion. Although 44 states at the secondary level and 33 at the postsecondary level initially agreed to use technical skill assessments as measures of skill attainment, not all of these are expected to follow through (U.S. Department of Education, 2010).

States introducing assessment programs have a range of options in selecting technical skill assessments. Some states (such as Georgia) are independently working to develop assessment systems based on their own state standards, whereas others are adopting national industry-recognized assessments (Hyslop, 2009). In the latter case, states often default to exams recognized by their own credential agencies, which typically cover occupations that may affect the health or well-being of the public, such as cosmetology or barbering (Klein & Charner, 2006). Industry-recognized exams are also widely employed, with states adopting occupation-specific exams used to gauge students' readiness to practice in the field. For example, many states have adopted National Automotive Technicians Education Foundation (NATEF) exams to evaluate students completing studies in targeted areas, such as automobile service, collision repair, and refinishing. Major software companies like Adobe, Microsoft, and Oracle also have developed certification assessments to recognize student mastery of specific design programs, such as Adobe ACE Macromedia Flash, Microsoft Certified SQL Server Administrator, and Oracle Forms Developer Associate (Southern Regional Education Board, 2009).

Technical skill assessments fall into two broad groups: general work readiness and occupation-specific assessments. General work readiness assessments are intended to measure skills that may transfer across most occupations. These exams measure students' knowledge of foundational work skills, such as the ability to follow directions, apply information, and work with others. In contrast, occupation-specific exams test students' mastery of technical skills associated with a particular job or narrow career area and often focus on assessing individuals' knowledge and ability to apply advanced content.

To date, states implementing standardized technical skill assessments at the high school level have relied primarily on narrowly focused exams that assess student readiness for entry-level employment in a particular job (Klein & Charner, 2006). Recent federal efforts to promote the development of college and career readiness standards may affect the direction in which these and other states' assessment systems move. Moreover, as the career clusters movement gains momentum, states also will have the option of adopting foundation-level exams that cut across multiple occupations within a specific business or

industry field.[3]

Although not typically employed for federal reporting purposes, some states also are using ACT's WorkKeys system to assess student attainment of career readiness skills. These include assessments to evaluate individuals' applied job skills in communication, problem solving, and interpersonal relations, as well as personal skills relating to performance/behavior, talent, and potential organizational fit.

One of the more popular testing options among states is provided by NOCTI. NOCTI was established as a consortium of states in the 1960s to coordinate research, test development, field-testing, and revision of occupational assessments. Before the establishment of NOCTI, states worked independently to develop occupational assessments; NOCTI coordinated and consolidated these efforts into its current organizational structure.[4] The organization now offers roughly 170 standardized technical assessments, which are used in CTE programs in at least seven states.

The NOCTI Job Ready skill assessments measure specialized, occupation-specific knowledge and skills associated with a particular job or narrow set of careers, such as architectural drafting or plumbing. The organization also offers a set of workplace readiness assessments that test students' attainment of broad, crosscutting skills and knowledge associated with a range of occupations. These exams are used in Pennsylvania to assess students for whom a NOCTI occupation-specific exam does not exist.

Linking Technical Skill Levels and Postsecondary Outcomes

Technical skills are usually defined through the skill standards, or those abilities and knowledge necessary for competent performance in carrying out responsibilities associated with the workplace (Stone, 2009). As such, most research on technical skill assessments has focused on workplace outcomes. In the 1970s and 1980s, these studies centered on assessments as predictors of earnings and occupational competency in industry and the armed forces. Much of the research explored the association between individuals' assessment scores and their likelihood of subsequent employment, earnings, and job performance, with some of the most exhaustive work performed by John Bishop. In particular, Bishop (1988) sought to assess the validity of the Armed Services Vocational Aptitude Battery as a predictor of earnings and job performance in military jobs. Bishop's analysis suggested that both the trade and technical subtests and the generic trade and technical competency tests of the battery are predictive of earnings for males, with less robust effects for other populations. Based on the generally positive associations found between technical assessments and labor market outcomes, Bishop noted that such assessments would have great potential for use in education settings, given their proven predictive value in the workplace (Bishop, 1993).

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[3] Career clusters are used to represent a grouping of career specialties/occupations and broad industries sharing common knowledge and skills required for career success. For detailed information on the career clusters initiative, see http://www.careerclusters.org/.

[4] For more information about the history of NOCTI, see *A Brief History of NOCTI,* http://www.nocti.org/History.cfm.

Bishop's advocacy for the use of technical skill assessments in education settings has found support in recent federal and state policies requiring measures of technical skill attainment among CTE students (Meeder, 2008). These policies have emerged in the context of increased accountability and standards-based education reforms emphasizing the acquisition of academic skills among all students. In CTE, these reforms have resulted in efforts to prepare students for college and careers and increase the rigor of instruction in both areas. Attendant strategies include linking secondary and postsecondary instruction, integrating academic skills in CTE courses and programs, and developing career cluster programs to teach skills associated with a related set of occupations, rather than a specific job (National Governors Association Center for Best Practices, 2007).

As CTE programs have changed, new research has emerged examining the effects of secondary level CTE participation on postsecondary outcomes. However, perhaps reflecting the recent advent of many state assessment programs, these studies generally use CTE program participation and concentration or completion as measures of students' CTE backgrounds. Most studies on workplace outcomes find positive effects of secondary CTE programs on earnings, although most of these studies are on individuals who graduated from high school in the 1970s and 1980s (Altonji, 1994; Gray & Huang, 1992; Kang & Bishop, 1986). Among those using more recent data, Bishop and Mane (2004) found that graduates who devoted one-sixth of their time in high school to CTE courses had higher earnings in the short and medium term than students who did not take any.

Reflecting efforts to ensure that CTE students have the academic skills necessary to enroll and succeed in higher education, other research has addressed postsecondary education outcomes. Outcomes include the type of postsecondary institution in which a student enrolled (Laird, Chen, & Levesque, 2006) and degree or certificate completion (Laird et al., 2006; Lekes et al., 2007). Research has also investigated the association between CTE coursetaking at the secondary level and postsecondary enrollment, the focus of the present study.

Two descriptive studies analyzing the postsecondary outcomes of 1992 high school graduates found that students who combined CTE and college preparatory courses were about as likely to enroll in postsecondary education as those who completed a college preparatory curriculum alone (Hudson & Hurst, 1999; Laird et al., 2006). By contrast, students who completed a CTE concentration alone enrolled in college at about half the rate of their peers in college prep programs. A study of career academies found traditional CTE concentrators to have a lower likelihood of college enrollment relative to students in career academies and college prep programs (Maxwell & Rubin, 2002).

As with the studies on workforce outcomes, however, the data in these studies are on students who completed their secondary schooling before the policy changes of the mid- to late-1990s. Using more recent data, DeLuca, Plank, and Estacion (2006) analyzed transcript data from the 1997 National Longitudinal Survey of Youth controlling for

student demographic and socioeconomic characteristics, high school GPA, engagement, and test scores. The study found that CTE coursetaking does not hinder college enrollment, but also that the higher the number of CTE relative to academic courses in a student's transcript, the lower the likelihood that the student will enroll in college.

These studies compare students in various CTE programs with students in college preparatory or academic programs, or programs that mix the two, with controls that include measures of academic achievement such as standardized math and reading test scores and GPA. CTE program experiences are differentiated only in terms of students' overall curriculum (e.g., participation in a career academy) or the proportion of academic versus CTE courses completed. The effects of CTE program participation, however, may vary according to the level of technical skills that students acquire through their experiences in the program. In part, the skills associated with academic and workplace success may overlap, as suggested by recent exploratory research comparing college and career readiness assessments (ACT, 2006). This overlap may be especially true of CTE fields that require math skills, like information technology (IT). A study of career pathways programs found IT students more likely than their peers in other programs to take advanced math courses (Lekes et al., 2007).

Technical skill proficiency may also be a proxy for a student's ability or motivation. Students with relatively higher levels of technical skill may be more likely to enroll in postsecondary education to enhance their skills further. Moreover, labor market analyses indicate that occupations once requiring only a high school degree now require postsecondary training for entry as technology and computer use has expanded (Silverberg, Warner, Fong, & Goodwin, 2004). As more and more occupations require postsecondary training, highly skilled students may recognize that higher education in a technical field may enhance their opportunities when they do decide to enter the workforce. Traditionally, secondary CTE graduates were expected to transition to work rather than college; today, both the characteristics of the labor market and CTE program reforms may be making postsecondary education a more appealing and viable option. Technical skill levels may be an indicator of which students are more likely to follow this route. This study seeks to extend the research on the postsecondary outcomes of CTE graduates by exploring the association between the technical skill levels that CTE students attain and their likelihood of postsecondary enrollment.

Research Design and Questions

This research effort seeks to identify the characteristics of CTE concentrators in Pennsylvania who complete a NOCTI technical assessment and to assess the association between students' technical skill levels and postsecondary outcomes. The analysis employs descriptive statistics to assess graduates' employment results and logistic regression to examine the relationship between technical skill assessment scores and receipt of an industry-recognized credential on postsecondary enrollment, holding constant factors such as student gender, rigor of high school studies, and GPA.

The dichotomous dependent variable in the multivariate analysis is whether a student

enrolled in higher education within a few years of high school graduation. Technical skill assessment score level and whether a student earned an industry certification are independent variables, and selected demographic and high school program variables serve as controls. Whether a concentrator earned an industry-recognized certificate is also included as an independent variable, because a growing number of states are using these certificates as measures of technical attainment (GAO, 2009). The logistic model is estimated separately for students taking occupation-specific and workplace readiness assessments and by CTE program area.

The paper opens with an examination of whether CTE concentrators' occupational competency assessment performance is related to their demographic characteristics and educational experiences during high school. Next, it assesses whether there is an association between technical skill levels and graduates' participation in academically rigorous, upper-division math and science high school classes, self-reported overall GPA, or the earning of one or more industry certifications. The last set of analyses focuses on whether there is an association between NOCTI exam score levels and postsecondary enrollment and whether enrollment varies by high school CTE program completed.

Data

Analyses are based on Pennsylvania high school graduates who completed their CTE program course requirements and took a NOCTI technical assessment in the 2005–2006 or 2006–2007 academic year, the most recent year for which follow-up data are available. The final dataset includes test scores produced by NOCTI; student demographic, educational transcript, and follow-up enrollment and employment data compiled from a dedicated CTE database maintained by the PDE; and postsecondary enrollment data obtained from the National Student Clearinghouse (NSC).

The dataset was compiled in three stages. First, student exam data were collected from NOCTI, which identified concentrators' names, occupational competency exam score(s), and a set of demographic data (gathered when the test was administered) for each secondary student tested in 2005–2006 or 2006–2007. These data, corresponding to 29,936 CTE concentrators, were matched with education record data maintained by the PDE, using concentrators' names and birthdays as unique identifiers. Record matches provided data on student characteristics (age, gender, and race/ethnicity), transcript information (including CTE program and advanced academic courses completed), industry certifications earned, and employment outcomes. Matches were obtained for 21,394 CTE graduates, or roughly 72% of students who were reported as taking a NOCTI exam in either 2005–2006 or 2006–2007.

Table 1. Total number of Pennsylvania CTE completers who took technical skill assessments and for whom follow-up data are available in the current dataset: 2005–2006, 2006-2007, and 2005–2006 and 2006–2007 combined

	2005–2006		2006–2007		2005–2006 and 2006–2007 combined	
Data	No.	%	No.	%	No.	%
Number of student score records reported by NOCTI[1]	15,384	100.0	14,552	100.0	29,936	100.0
Number of secondary student records for whom NOCTI reported a test score and for whom a match was found in PDE CAT data (dataset total)	11,083	72.0	10,311	70.9	21,394	71.5
Dataset total	11,083	100.0	10,311	100.0	21,394	100.0
Number of records with an National Student Clearinghouse match	4,564	41.2	4,284	37.9	8,848	41.4
Number/percent with a PDE follow-up survey	3,911	35.3	2,217	19.6	6,128	28.6
Number/% with NSC match *or* PDE follow-up survey	6,578	59.4	5,323	47.1	11,901	55.6
Number/% with NSC match *and* PDE follow-up survey	1,897	17.1	1,178	10.4	3,075	14.4

[1] Includes adult education students, which are excluded from the other rows.

SOURCE: National Occupational Competency Testing Institute, National Student Clearinghouse, and the PDE.

To collect post-program employment data, the PDE conducts an annual survey of CTE students who completed a CTE program either in a comprehensive high school or at a CTE center and graduated the preceding academic year.[5] This online survey requests recipients to self-report on their enrollment and employment experiences in the second quarter following high school completion. For example, a CTE concentrator graduating in June 2006 would report on his or her enrollment and employment outcomes for October 1–December 31, 2006. Between 2005–2006 and 2006–2007, the PDE sent out a follow-up survey request to 21,213 CTE concentrators who graduated from high school. A total of 6,081 surveys were received, which equates to a roughly 29% response rate for the two-year period.

Postsecondary enrollment data were obtained by transmitting record identifiers for CTE concentrators to the NSC for matching against the clearinghouse database.[6] (A complete

[5] In 2004-2005 (the most recent year for which data are available), 67% of CTE completers attended area CTE centers (AVTS), and 33% attended a comprehensive high school (PDE, 2006).

[6] The NSC maintains data for over 3,300 institutions of higher education, enrolling 92% of all U.S. college students. Data include information on public and private colleges and universities, as well as many private trade schools. A listing of participating institutions can be downloaded from: http://www.studentclearinghouse.org/.

list of variables and their sources is included in Appendix Table 1).[7] For the analysis in this report, data were limited to students ages 19 or younger (i.e., adults participating in CTE coursework offered at a secondary institution were excluded). The final dataset produced by the NSC for postsecondary enrollment includes information for 21,228 students, of whom 8,777, or roughly 41%, were found to be enrolled.

Technical Skill Assessments in Pennsylvania

The use of technical assessments in Pennsylvania predates the technical skill accountability requirements of Perkins IV. In 1996, the Pennsylvania State Board of Education approved the use of student occupational competency assessments for all secondary and adult CTE program concentrators scheduled to graduate (PDE, 2009). In the 2005–2006 and 2006–2007 academic years, an estimated 80% of Pennsylvania CTE program completers took a technical assessment near the end of their program. Students who were in programs with associated technical skills assessments were required to take the exam; students in other programs were issued waivers and could choose to take a general workplace readiness exam.[8] Among the students who took any assessment, nearly all were of NOCTI origin.

In Pennsylvania, the majority of NOCTI assessments measure entry-level, job-ready knowledge and skills that are aligned with industry-validated CTE program standards (Munyofu, 2007). These exams are drafted by teams that include experts from industry and education who participate in drafting, piloting, and revising the assessments to ensure each test's validity and reliability.[9] High school students take the NOCTI exam in March, April, or May of their senior year, following the completion of the majority of their CTE program requirements. All of the NOCTI exams designed to test occupation-specific skills in Pennsylvania in 2005–2006 and 2006–2007 had both written and performance components that required examinees to demonstrate content knowledge and the ability to perform occupation-specific tasks.[10]

Students in CTE programs that were not associated with a NOCTI occupation-specific exam had the option to take a workplace readiness exam. Administered in written form (no performance component exists), the assessment gauges a spectrum of generic skills

[7] The complete appendix of tables is available on the NRCCTE website at: http://136.165.122.102/UserFiles/File/NOCTI_PDE_CTE/NOCTI_PDE_Appendix_Tables_FINAL.pdf

[8] In 2005–2006, program completers were students who had completed CTE program requirements set at the school level. In 2007–2008, Pennsylvania phased out its written-only exams, including the general workplace readiness exam documented in this study. Currently, Pennsylvania requires that all technical assessments have a performance component (four exams in 2005–2006 and five in 2006–2007 had no performance component). Pennsylvania also phased out most of the technical skill assessments provided by other vendors, such that, as of the 2008–2009 program year, an estimated 95% of students completing CTE programs took a required end-of-program NOCTI exam (interview with Dr. Paul Munyofu, Research Associate, PDE Bureau of Career and Technical Education, July 20, 2009).

[9] For details on NOCTI's test development process, see http://www.nocti.org/PDFs/DevelopmentRevisionataGlance.pdf.

[10] The 2- to 3-hour written test has about 200 multiple choice items, and the 3- to 4-hour performance test requires the test taker to complete a series of tasks associated with two to seven occupation-specific jobs or activities (Munyofu & Kohr, 2009).

applicable to most industries and career areas. The exam includes questions to assess students' capacity to communicate and solve problems, as well as their understanding of teamwork and leadership abilities.

Technical Skill Levels

The Bureau of Career and Technical Education at the PDE sets cut points that determine four score levels. The written exam cut points that determine the levels are reassessed roughly every two years, corresponding to when NOCTI assessments are revised and updated. Results for the performance portion of the assessment are evaluated by industry practitioners using criteria in the assessment's evaluator guide provided by NOCTI. The cut scores for this portion of the assessments are uniform across all exam types.

Pennsylvania has established a system for establishing criterion-referenced benchmarks for the written exams using the Nedelsky method (Munyofu & Kohr, 2009). The cut scores are set by 12- to 15-member panels composed of CTE teachers and industry representatives. Panel judges individually review each test item and identify the answers that a minimally competent test taker would be able to recognize as obviously wrong before resorting to guessing on the remaining choices. The mean of the panel judges' scores becomes the percent cut score for the test.[11]

These resulting levels are:

- *Advanced Level:* Reflects mastery of competence and understanding of academic/career and technical skills and knowledge required for advanced placement in employment and/or postsecondary education.
- *Competent Level:* Reflects a solid acquisition of academic/career and technical skills and knowledge required to enter employment and/or postsecondary education.
- *Basic Level*: Reflects an adequate attainment of academic/career and technical skills and knowledge required to enter employment or postsecondary education. Students with this score "would function at an entry level, but would require some assistance on the job."
- *Below Basic Level:* Reflects a partial acquisition of skills and knowledge needed to perform a given assignment, task, or operation on the job. Additional instruction and/or assistance are necessary in order for the student to successfully complete specific assignments. Students with this score have not acquired the minimum skills required for an occupation.[12]

In addition to course requirements, to complete a CTE program, students must achieve a score at or above the basic level. Students scoring at the two highest levels earn certificates: the Pennsylvania Competency Certificate, if their overall score is at the competent level, and the Pennsylvania Skills Certificate, if they score at the advanced

[11] For detailed descriptions of how the cut scores are determined, see Munyofu, 2008, and Munyofu and Kohr, 2009.

[12] See http://www.pde.state.pa.us/career_edu/lib/career_edu/2008_Certification_Guide.pdf.

level. Aside from measuring skill attainment, occupational competency exam results have other uses, including the identification of low-performing districts by the PDE. The state and districts negotiate yearly improvement goals, of which student performance on occupational competency assessments represents one component. Students may also use their occupational competency results to earn postsecondary credits (or a waiver of program requirements) in accordance with agreements between individual high schools or districts and postsecondary institutions.[13]

Results

The next sections first present descriptive statistics on the percentage of CTE completers who took occupation-specific and workplace readiness assessments, by technical skill level, and the percentage of CTE graduates who took an assessment, by CTE program area and technical skill level. The subsequent section compares technical skill levels by type of CTE program completed, gender, race/ethnicity, the number of advanced math and science courses passed, and self-reported GPA. The final set of descriptive statistics compares the technical skill levels of students who earned and did not earn one or more industry certifications.[14] The concluding sections present logistic regression analyses predicting the effects of technical skill levels on postsecondary educational enrollment.

Descriptive Statistics

Skill level by exam type. The 2005–2006 and 2006–2007 test taker data include test scores for 85 different exams. Overall, nearly 86% of students completed an occupation-specific exam at some point during the two-year study period, indicating that the majority of Pennsylvania high school CTE curricular offerings are perceived as aligned with NOCTI assessments.[15] Students for whom a NOCTI exam does not exist took a workplace readiness exam.

[13] Interview with Dr. Paul Munyofu, Research Associate, PDE Bureau of Career and Technical Education, July 20, 2009.

[14] Comparisons reported in the text were tested using Pearson's chi-square test for independence and are significant at the $p < .05$ level.

[15] For occupation-specific exams, the largest group of assessments administered was in Cosmetology (8% of exams), followed by Food Production and Management, Carpentry, and Early Childhood Care (about 4% each). See Appendix Table 2 for the percentage of students taking specific exams overall and Appendix Table 3 for test-taking rates by CTE program area.

Table 2. Percentage of CTE graduates who took occupation-specific and workplace readiness assessments, by technical skill level: 2005–2006 and 2006–2007

	2005–2006 and 2006–2007				2005–2006				2006–2007			
	Occupation-specific		Workplace readiness		Occupation-specific		Workplace readiness		Occupation-specific		Workplace readiness	
Skill Level	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Below Basic	4,569	25.1	545	17.8	2,195	23.9	340	18.4	2,374	26.4	205	16.9
Basic	3,501	19.3	549	18.0	1,826	19.9	321	17.4	1,675	18.6	228	18.8
Competent	2,479	13.6	386	12.6	1,310	14.3	253	13.7	1,169	13.0	133	11.0
Advanced	7,623	41.9	1,576	51.6	3,834	41.8	929	50.4	3,789	42.1	647	53.3
Percentage by assessment type	18,172	85.6	3,056	14.4	9,165	83.3	1,843	16.7	9,007	88.1	1,213	11.9

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

Students were relatively successful in their assessment efforts across the two program years. As detailed in Table 2, a majority scored at the advanced level on both the workplace readiness and occupation-specific assessments. However, a greater proportion of students taking workplace readiness exams (52%) achieved the advanced performance level than those taking occupation-specific (42%) exams. This may reflect the more challenging nature of the career-specific exams, which require that students demonstrate an advanced set of job-focused skills within a focused area of study. Although relatively similar proportions of students scored at the competent and basic score levels on both types of assessments, a larger percentage of students taking occupation-specific exams scored at the below basic level compared to those taking workplace readiness assessments (25% vs. 18%, respectively).

Skill level by CTE program area. The PDE categorizes NOCTI exams by program type for reporting purposes (PDE, 2006). Over the two program years, a majority of students completed coursework in the Trade and Industrial Education program area (54%), followed by Occupational Home Economics Education (12%) and Business Education/Marketing and Distributive Education (11%).[16]

[16] This analysis combines the "Business Education" and "Marketing and Distributive Education" groups.

Table 3a. Percentage distribution of all CTE graduates who took either type of assessment and those who took a workplace ready assessment, by CTE program area: 2005–2007

	Any NOCTI assessment		Workplace readiness assessment		
Program Area	No.	Percentage distribution	No.	%	Percentage distribution
Agriculture Education	1,026	4.8	108	10.5	3.5
Business Education/ Marketing and Distributive Education	2,363	11.1	133	5.6	4.4
Health Occupations Education	2,058	9.6	344	16.7	11.3
Occupational Home Economics Education	2,535	11.9	49	1.9	1.6
Trade and Industrial Education	11,478	53.7	523	4.6	17.1
Other (not elsewhere classified)[1]	1,934	9.0	1,899	98.2	62.1

[1] Includes career exploration/awareness skills, diversified occupations, and vocational education, other.

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

Students enrolling in CTE coursework that cannot be classified into a specific program area or those concentrating in programs for which a NOCTI occupation-specific exam is not available are tested using a workplace readiness exam. As illustrated in Table 3a, roughly 98% of students taking other CTE coursework (i.e., could not be classified) completed such a workplace readiness assessment. Students who could be classified into a program area, but for whom a NOCTI occupation-specific exam did not exist also take a workplace readiness exam. Among these students, the largest population was taking coursework in the health occupations (17%), followed by agriculture (11%).

Student performance on NOCTI assessments varies by program area. The percentage of students scoring at the advanced level was highest in the health occupations for students taking both occupation-specific (61%) and workplace readiness (60%) exams. Generally, skill levels were different for workplace readiness exams and occupation-specific exams, with overall scores higher for workplace readiness than occupation-specific assessments. The exceptions are health occupations and occupational home economics, for which the association between exam type and score level was not significant ($p < .01$).

Table 3b. Percentage distribution of CTE graduates who took NOCTI assessments, by CTE program area and technical skill level: 2005–2006 and 2006–2007 (combined)

	Program Area											
	Agriculture		Business/ Marketing & Distribution		Health Occupations		Occupational Home Economics		Trade and Industrial		Other[1]	
Skill Level	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Occupation-specific												
Below Basic	334	36.4	757	34.0	190	11.1	476	20.5	2,797	25.5	15	42.9
Basic	161	17.5	384	17.2	266	15.5	424	18.3	2,258	20.6	8	22.9
Competent	113	12.3	285	12.8	216	12.6	306	13.2	1,558	14.2	1	2.9
Advanced	310	33.8	804	36.1	1,042	60.8	1,114	48.0	4,342	39.6	11	31.4
Workplace readiness												
Below Basic	18	16.7	7	5.3	21	6.1	16	32.7	117	22.4	366	19.3
Basic	25	23.1	18	13.5	59	17.2	9	18.4	88	16.8	350	18.4
Competent	14	13.0	15	11.3	57	16.6	9	18.4	70	13.4	221	11.6
Advanced	51	47.2	93	69.9	207	60.2	15	30.6	248	47.4	962	50.7

[1] Includes career exploration/awareness skills, diversified occupations, and vocational education, other.

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

Students taking CTE coursework in the other (not elsewhere classified) category had the lowest percentage of results at the advanced or competent levels on an occupation-specific exam. This result might be expected if these students took an occupation-specific exam for which they were not adequately prepared. However, because most students in this situation took workplace readiness exams, it is difficult to infer much from this finding. Indeed, students not elsewhere classified performed relatively highly on workplace readiness skills, suggesting that a majority of these students were given a solid foundation of work preparation skills.

Skill level by demographic characteristics. To assess the effect of gender and race/ethnicity on student performance, researchers disaggregated NOCTI exam results. As illustrated in Table 4, more students took occupation-specific rather than workplace readiness exams, although a higher percentage of males than females did so (89% vs. 82%, respectively).

Table 4. Percentage distribution of CTE graduates who took a NOCTI exam, by technical skill level and gender and race/ethnicity: 2005–2007

	Gender				Race/Ethnicity							
	Female		Male		Asian		Black		Hispanic		White	
Skill Level	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Total	**9,388**	**44.9**	**11,528**	**55.1**	**143**	**0.7**	**1,193**	**5.6**	**830**	**3.9**	**19,030**	**89.8**
Occupation-specific	7,712	82.1	10,199	88.5	117	81.8	1,024	85.8	665	80.1	16,333	85.8
Workplace readiness	1,676	17.9	1,329	11.5	26	18.2	169	14.2	165	19.9	2,697	19.9
Occupation-specific	**7,712**	**100.0**	**10,199**	**100.0**	**117**	**100.0**	**1,024**	**100.0**	**665**	**100.0**	**16,333**	**100.0**
Below Basic	1,588	20.6	2,918	28.6	30	25.6	411	40.1	188	28.3	3,928	24.1
Basic	1,548	20.1	1,904	18.7	25	21.4	190	18.6	142	21.4	3,136	19.2
Competent	1,100	14.3	1,346	13.2	15	12.8	118	11.5	101	15.2	2,242	13.7
Advanced	3,476	45.1	4,031	39.5	47	40.2	305	29.8	234	35.2	7,027	43.0
Workplace readiness	**1,676**	**100.0**	**1,329**	**100.0**	**26**	**100.0**	**169**	**100.0**	**165**	**100.0**	**2,697**	**100.0**
Below Basic	222	13.3	313	23.6	4	20.0	47	27.8	49	29.7	443	16.4
Basic	286	17.1	251	18.9	4	20.0	43	25.4	31	18.8	469	17.4
Competent	239	14.3	144	10.8	9	15.0	26	15.4	17	10.3	340	12.6
Advanced	929	55.4	621	46.7	9	45.0	53	31.4	68	41.2	1,445	53.6

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

The largest percentages of males and females scored at the advanced level, relative to the percentages who scored at the lower levels on both types of exams, with higher percentages of females than males at this level (45% vs. 40% for occupation-specific exams, and 55% versus 47% for workplace readiness exams, respectively). Fewer females than males also scored at the below basic level for both exams.

A majority of NOCTI test takers were White (90%), followed by Black (6%), Hispanic (4%), and Asian (1%). Over 80% of the students in all racial/ethnic groups took an occupation-specific exam, though higher percentages of Whites and Blacks took these exams (86%) than Hispanics (80%) and Asians (82%).

With the exception of Black students, the largest proportion of students in all racial/ethnic groups scored at the advanced level on occupation-specific exams, with 43% of White, 40% of Asian, and 35% of Hispanic students achieving advanced status. A higher percentage of Black students scored at the below basic than at the advanced level (40% vs. 30%, respectively).

Skill level by course rigor and high school grade point average. The PDE maintains data on all advanced courses passed by each CTE student above the minimum required for graduation.[17] Past research on student transcripts has found advanced math and

[17] The Bureau of Career and Technical Education maintains a subset of academic and program level data

science courses to be strongly associated with postsecondary attendance, grades, and degree completion (Adelman, 1999, 2006). The analysis therefore excludes non-math and science courses, Algebra I/IB and Biology I, Applied Geometry, Anatomy and Physiology, and the level I courses of other math and science sequences. The number of the remaining courses passed, which include Advanced Placement math and science courses, Algebra II, and Trigonometry, were totaled for each student. CTE graduates were classified into three categories based on the number of upper-division math and science courses they passed: none, one to two courses, and three or more courses. Table 5 summarizes student coursetaking patterns and technical skill levels.

Table 5. Percentage distributions of CTE graduates' technical skill levels, by exam type and the number of advanced math and science courses passed: 2005–2007

	No courses		1–2 courses		3 or more courses	
Skill Level	No.	%	No.	%	No.	%
Occupation-specific						
Below Basic	2,040	32.2	1,760	23.0	769	18.3
Basic	1,317	20.8	1,572	20.6	612	14.6
Competent	848	13.4	1,081	14.1	550	13.1
Advanced	2,123	33.6	3,236	42.3	2,264	54.0
Total	6,328	100.0	7,649	100.0	4,195	100.0
Workplace readiness						
Below Basic	237	27.8	215	18.3	93	9.1
Basic	208	24.4	212	18.0	129	12.6
Competent	103	12.1	170	14.5	113	11.0
Advanced	306	35.8	578	49.2	692	67.4
Total	854	100.0	1,175	100.0	1,027	100.0

[1] Includes career exploration/awareness skills, diversified occupations, and vocational education, other.

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

Irrespective of exam type, students taking more upper-division academic coursework scored at the highest levels on NOCTI tests. For example, over one-half (54%) of students who passed three or more upper-division math and science courses achieved the advanced level on a NOCTI occupation-specific exam, as compared with just over one-third (34%) of those who did not pass an upper-division course. These findings may indicate that students completing relatively more upper-division academic courses possess cognitive abilities or personal motivation that enable them to perform at higher levels on NOCTI exams than those lacking such personal characteristics.

Students taking a technical skill assessment are asked to include their high school GPA in a short questionnaire administered with the written test. About 15% reported an A average, 52% a B average, 31% a C average, and 2.2% an average grade of D or lower.

for CTE students, including academic coursetaking. See Appendix Table 4 for a complete list of the academic courses included in the PDE student file. Courses in the secondary category (upper-division advanced math and science courses) are marked with an asterisk in the Appendix Table.

Table 6 summarizes students' exam scores by their self-reported GPA and combines the two lowest categories into a single category for C or lower.

Table 6. Percentage distributions of students' technical skill levels, by assessment type and self-reported average high school GPA: 2005–2006 and 2006–2007 (combined)

	Average GPA of A		Average GPA of B		Average GPA of C or lower	
Skill Level	No.	%	No.	%	No.	%
Occupation-specific						
Below Basic	517	18.8	2,165	24.0	1,740	29.9
Basic	453	16.5	1,711	19.0	1,232	21.1
Competent	339	12.3	1,224	13.6	812	13.9
Advanced	1,445	52.5	3,925	43.5	2,044	35.1
Total	2,754	100.0	9,025	100.0	5,828	100.0
Workplace readiness						
Below Basic	44	10.5	247	15.2	249	25.2
Basic	60	14.3	283	17.4	204	20.7
Competent	31	7.4	236	14.5	115	11.6
Advanced	284	67.8	859	52.9	420	42.5
Total	419	100.0	1,625	100.0	988	100.0

[1] Includes career exploration/awareness skills, diversified occupations, and vocational education, other.

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

The results reveal a positive association between GPA and technical assessment score ($p < .01$). The majority of students reporting a GPA of A scored at the advanced level on the occupation-specific and workplace readiness exams (53% and 68%, respectively). The lowest percentages of students with scores at the advanced level are found among those who reported a GPA of C or lower. This group of students also had the highest percentages of students scoring at the basic and below basic levels.

Industry certifications. Pennsylvania secondary CTE students may earn industry-recognized certifications during high school. To assist local school districts in identifying certifications for which their students may be eligible, the PDE publishes a guide that lists known industry-recognized certifications by CTE program (PDE, 2008a). Fees for certification tests are covered by individual school districts, which help to ensure that students who elect to take an exam have completed the necessary preparatory coursework to succeed. About 10% of the students in the current dataset had earned an industry certification during high school. Just over half of these students (58%) earned one certification, and another 26% had two or three.[18] Table 7a summarizes the percentage of students in each CTE program category that earned a certification. The highest percentage of students earning an industry certification was in health occupations education (33%), followed by occupational home economics education (19%).

[18] For a complete list of certifications, and the number of certifications earned by certification type, see Appendix Table 5.

Table 7a. Percentage of secondary CTE graduates who took a NOCTI technical skills assessment who earned an industry certification, by CTE program area: 2005–2006 and 2006–2007 (combined)

Program Area	No. of students	Earned an industry certification	
		No.	%
Total	21,394	2,145	10.0
Agriculture Education	1,026	36	3.5
Business Education/Marketing and Distributive Education	2,363	151	6.4
Health Occupations Education	2,058	679	33.0
Occupational Home Economics Education	2,535	488	19.3
Trade and Industrial Education	11,478	782	6.8
Other (not elsewhere classified)[1]	1,934	9	0.5

[1] Includes career exploration/awareness skills, diversified occupations, and vocational education, other.
SOURCE: PDE, Bureau of Career and Technical Education.

These findings may reflect the relatively higher proportion of industry certifications available in some programs, rather than the success of the program itself.[19] For example, the most popular certifications in 2005–2006 and 2006–2007 were issued by the American Red Cross, and hence catalogued into the Health Occupations area. The most common certification was Infant, Child, and Adult CPR (cardiopulmonary resuscitation) (12% of all industry certifications earned), followed by First Aid (9%), and Adult CPR/AED (cardiopulmonary resuscitation/automated external defibrillators; 8%).

Although certification tests often cover a far narrower range of skills than NOCTI occupation-specific assessments, a higher percentage of students earning one or more industry certification than students who did not earn a certification scored at the advanced level on both the workplace readiness and occupation-specific exams.[20] Certifications may therefore indicate skill or motivation levels similar to those found among students who score at a high level on an occupational competency assessment.

[19] It also may be that students have greater use for some assessments. For example, the relative popularity of American Red Cross exams may reflect students seeking certification so that they can pursue babysitting employment.
[20] Interview with Dr. Paul Munyofu, Research Associate, PDE Bureau of Career and Technical Education, July 20, 2009.

Table 7b. Percentage of secondary CTE graduates who took a NOCTI technical skills assessment who earned an industry certification, by technical skill level: 2005–2006 and 2006–2007 (combined)

	Earned an industry certification			
	Yes		No	
Skill Level	No.	%	No.	%
Occupation-specific assessment score level				
Below Basic	240	12.4	4,391	26.7
Basic	308	15.9	3,240	19.7
Competent	261	13.5	2,249	13.7
Advanced	1,132	58.3	6,598	40.0
	1,941	100.0	16,478	100.0
Workplace readiness assessment score level				
Below Basic	14	7.2	536	18.5
Basic	33	17.0	526	18.2
Competent	32	16.5	358	12.4
Advanced	115	59.3	1,477	51.0

[1] Includes career exploration/awareness skills, diversified occupations, and vocational education, other.
SOURCE: PDE, Bureau of Career and Technical Education.

Although students who earned a certification represent just a tenth of the test takers included in the current dataset, their numbers are expected to grow. The Bureau of Career and Technical Education is working to increase the number of students earning industry certifications/credentials by 30% by 2010, a goal that may reflect national trends.[21] Other states are also encouraging students to earn industry certifications; Florida, for example, recently passed an act requiring industry-recognized certifications for CTE program completion at the secondary and postsecondary levels.[22]

Postsecondary employment. Students who earn a relatively high score on a NOCTI occupation-specific or workplace readiness assessment might be expected to possess a set of skills that better prepare them for post-program success. This may be manifested by a higher likelihood of finding employment immediately following high school. To assess the post-program outcomes of CTE graduates, researchers matched student performance data on the NOCTI exams with information collected by the PDE follow-up survey and maintained at the NSC.

The PDE collects data on the employment status of all CTE program graduates in the second quarter (i.e., September 1–December 31) following their high school completion. Information is collected using an online survey instrument, which asks individuals to self-report if they were employed and/or enrolled at any point during the period.[23] State

[21] See http://www.portal.state.pa.us/portal/server.pt/community/bureau_of_career___technical_education/7334.
[22] Florida Career and Professional Education Act (CAPE) of 2007.
[23] Because students are not asked to provide information on their employment field, length of experience, or status (i.e., full-time or part-time), it is not possible to gauge whether their post-program experiences are related to their in-school training.

records indicate that a total of 21,213 survey requests were sent out to CTE concentrators in the 2005–2006 and 2006–2007 program years. Of these surveys, a total of 6,081 (32%) were returned with usable information.

Analysis of missing data indicates that the lower a graduate's technical assessment score, the lower the likelihood that they would return a follow-up survey: nearly one-third (32%) of students scoring at the advanced level responded to the survey request, compared with less than one-quarter (23%) of those at the below basic level. This result might be expected if student performance is associated with post-program work or college placement; those failing to find work or enroll in college might be less motivated to report on their negative post-high school experiences (Baj, Trott, & Stevens, 1991).[24]

Table 8a. Number and percentage distribution of CTE graduates who took NOCTI exams and returned a follow-up survey, by technical skill level and reported postsecondary status: 2005–2006 and 2006–2007 (combined)

		Technical Skill Level							
Follow-up Survey	Total	Advanced	%	Competent	%	Basic	%	Below Basic	%
PDE follow-up survey[1]	21,213	9,189	100.0	2,863	100.0	4,049	100.0	5,112	100.0
Respondent	6,081	2,978	32.4	864	30.2	1,062	26.2	1,177	23.0
Non-respondents	15,136	6,214	67.6	1,999	69.8	2,987	73.8	3,936	77.0
Occupation-specific assessment	5,185	2,462	100.0	739	100.0	929	100.0	1,055	100.0
Enrolled only	1,359	667	27.1	164	22.2	217	23.4	311	29.5
Enrolled and employed	1,725	898	36.5	253	34.2	289	31.1	285	27.0
Employed only	1,746	769	31.2	285	38.6	348	37.5	344	32.6
Unemployed (not enrolled)	355	128	5.2	37	5.0	75	8.1	115	10.9
Workplace readiness assessment	896	516	100.0	125	100.0	133	100.0	122	100.0
Enrolled only	200	133	25.8	27	21.6	22	16.5	18	14.8
Enrolled and employed	421	246	47.7	61	48.8	66	49.6	48	39.3
Employed only	242	127	24.6	30	24.0	37	27.8	48	39.3
Unemployed (not enrolled)	33	10	1.9	7	5.6	8	6.0	8	6.6

[1] Detail presented here does not sum to the total of 8,848 NSC matches found and the 6,128 PDE surveys because comparable exam scores were not possible to calculate for all assessments.

NOTE: Excludes students over 19 and students who did not graduate in the year they took the test.

SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

Tests of association were conducted between technical skill levels, assessment types, and employment and education status as reported in the follow-up survey. Technical skills

[24] Specifically, when assessing the feasibility of using Unemployment Insurance wage record data to assess Job Training Partnership Act (JTPA) programs, Baj et al. (1991) found that 70.2% of those employed at program termination responded to their survey request versus 49.6% of those unemployed.

levels are positively associated with education status for both types of assessments, and for employment status for occupation-specific assessments only. The results did not indicate that the relationship between technical skill levels and employment or education status differed between the two types of assessment. This result may reflect the relatively small proportion of graduates that responded to the survey, particularly among those who took a workplace readiness assessment.

Postsecondary enrollment. Identifiers for CTE graduates taking NOCTI assessments were matched against records maintained by the NSC to identify students who attended college at any time between their high school graduation and the fall of 2009, the time at which the match occurred. A total of 21,228 records were shared with the NSC, and a total of 8,777 matches (41%) achieved.[25] These data likely underestimate the actual enrollment of Pennsylvania CTE graduates, because it is possible that there was a discrepancy between the name and birth date listed for a student in the PDE and those maintained by the NSC. It is also possible that an individual attended a postsecondary institution not included in the NSC database.[26] Although mismatches due to name and birth date discrepancies are unlikely to be correlated with technical skill assessments, those due to students enrolling in an institution not reporting to the NSC could bias results if unaffiliated institutions were more likely to enroll students with lower test scores.

Table 8b. Number and percentage distribution of CTE graduates who took NOCTI assessments, by technical skill level and postsecondary enrollment status: 2005–2006 and 2006–2007 (combined)

		Technical Skill Level							
Follow-up Survey	Total	Advanced	%	Competent	%	Basic	%	Below Basic	%
National Student Clearinghouse (NSC)[1]	21,228	9,199	100.0	2,865	100.0	4,050	100.0	5,114	100.0
Enrolled	8,777	4,446	48.3	1,201	41.9	1,441	35.6	1,689	33.0
Not enrolled	12,451	4,753	51.7	1,664	58.1	2,609	64.4	3,425	67.0
Occupation-specific	18,172	7,623	100.0	2,479	100.0	3,501	100.0	4,569	100.0
Enrolled	7,155	3,471	45.5	998	40.3	1,186	33.9	1,500	32.8
Not enrolled	11,017	4,152	54.5	1,481	59.7	2,315	66.1	3,069	67.2
Workplace readiness	3,056	1,576	100.0	386	100.0	549	100.0	545	100.0
Enrolled	1,622	975	61.9	203	52.6	255	46.4	189	34.7
Not enrolled	1,434	601	38.1	183	47.4	294	53.6	356	65.3

SOURCE: National Occupational Competency Testing Institute, National Student Clearinghouse, and the PDE.

[25] Because detailed information on enrollment status was not available, it is neither possible to determine the type of institution an individual attended (i.e., two-year or four-year college or university, trade school, etc.) or the length of time for which a student was in attendance.

[26] Some 94% of headcount enrollments in Pennsylvania were included in the NSC in 2005, but percentages for other states ranged from as high as 99% to as low as 67% (National Center for Higher Education Management Systems, 2005).

Overall, enrollment in a postsecondary institution was positively correlated with NOCTI test scores, and this finding held irrespective of whether students took a workplace readiness or occupation-specific exam. However, a higher percentage of students with scores at or above the basic competency level on a workplace readiness assessment enrolled in postsecondary education than those taking occupation-specific assessments. For example, 62% of students scoring at the advanced level on a workplace readiness exam were found to be enrolled at some point in the study period, compared with 46% of those scoring at the advanced level on an occupation-specific exam. Individuals scoring at the below basic level were least likely to be found enrolled, and relatively little difference was found between those scoring below basic on different types of assessments.

Multivariate Analysis

The multivariate analyses assess the association between a high school CTE graduate's technical skill attainment level (as measured by a technical competency exam score) and postsecondary enrollment. The analyses use sequential logistic regression to estimate a set of nested binary logistic regression models of postsecondary enrollment among NOCTI occupation-specific and workplace readiness test takers. The outcome is whether a student enrolled in postsecondary education (as measured by an NSC match). Low survey response rates and the relatively small number of respondents reporting unemployment status precluded the estimation of models using employment measures as dependent variables.

Table 9 summarizes descriptive statistics for the variables in the estimated equation for students who took an occupation-specific exam and students who took a workplace readiness exam. The dichotomous dependent variable indicates whether a student enrolled in one of the institutions of higher education included in the NSC at any time between high school graduations in 2005–2006 or 2006–2007 through the 2009 calendar year.[27] Students identified as enrolled may or may not have been seeking a degree, and may have been enrolled at any point during the period covering from when they graduated high school and the time that study measurements were made in the fall of 2009.

[27] Because one more year of data is available for 2005–2006 than 2006–2007 graduates, the data may underestimate higher education enrollment for 2005–2006 graduates relative to 2006–2007 graduates. A Pearson's chi-square test of independence ($p < .01$) for graduation year and higher education enrollment was not significant, and the variable for graduation year was not significant ($p < .01$) when included in the full logit model (results available upon request from the authors).

Table 9. Descriptive statistics for variables used in the analysis of the effect of NOCTI occupation-specific assessment score level on postsecondary enrollment

Variable	Occupation-Specific	Workplace Readiness
Enrolled in postsecondary education anytime between graduation (2005–2006 or 2006–2007) and 2009	0.39	0.53
NOCTI assessment score level		
Advanced	0.42	0.52
Competent	0.15	0.13
Basic	0.19	0.18
Below Basic[1]	0.25	0.18
Earned an industry certification	0.11	0.06
Control Variables		
Female	0.43	0.56
Ethnicity		
Asian	0.06	0.66
Hispanic	0.06	0.06
Black	0.04	0.05
White[1]	0.90	0.88
Advanced (upper-division) STEM courses passed		
3 or more courses	0.35	0.34
1–2 courses	0.42	0.38
None[1]	0.23	0.28
Self-reported grade point average		
A	0.16	0.14
B	0.51	0.54
C or lower[1]	0.33	0.33

[1] Reference category.

SOURCE: National Occupational Competency Testing Institute, National Student Clearinghouse, and the PDE.

The independent variables are dummy variables for a student's overall technical assessment score level (advanced, competent, basic, and below basic as the reference category), and whether a student earned an industry certification. The control variables are factors associated with postsecondary enrollment, including gender, race/ethnicity (reference category: White), passage of advanced math and science courses during high school (reference category: none), and self-reported GPA (reference category: C or lower).

Table 10 presents the results of several logistic regression models estimated for graduates that took an occupation-specific NOCTI assessment. The models evaluate the effects of students' technical skill levels in a specific occupational area, and earning an industry

certification on postsecondary enrollment while controlling for student demographic and academic background characteristics.[28] Model 1 includes just the demographic variables (gender and race/ethnicity). Model 2 includes demographic characteristics and secondary academic background variables (passage of advanced science and math courses and self-reported GPA). Model 3 adds the two measures of technical skill achievement: whether a student earned an industry certification and technical assessment score level.

[28] The results are presented as odd ratios (for coefficients in terms of log odds, see Appendix Table 6). Odds ratios are calculated by taking the natural antilogarithms of the logit coefficients. Values exceeding 1 indicate that students in a particular group (e.g., students scoring at the advanced level on a technical skills assessment) have higher odds of enrolling in a postsecondary institution than the comparison group or omitted category (e.g., students who scored at the below basic level) and values less than 1 indicate lower odds.

Table 10. Logit models of postsecondary enrollment among NOCTI occupation-specific test takers: 2005–2006 and 2006–2007

	Model 1				Model 2				Model 3			
	Odds Ratio		SE	95% CI	Odds Ratio		SE	95% CI	Odds Ratio		SE	95% CI
Ethnicity[1]												
Asian	2.91	*	.575	1.97-4.28	2.17	*	.446	1.47-3.24	2.21	*	.457	1.47-3.31
Black	1.58	*	.103	1.38-1.79	1.74	*	.120	1.52-1.99	1.84	*	.128	1.60-2.10
Hispanic	1.20		.098	1.03-1.41	1.37	*	.116	1.16-1.62	1.41	*	.121	1.19-1.66
Gender (Female=1)	1.55	*	.048	1.45-1.64	1.47	*	.047	1.37-1.56	1.45	*	.048	1.36-1.55
Advanced (upper-division) STEM courses passed[2]												
3 or more courses					4.05	*	.178	3.71-4.41	3.83	*	.171	3.51-4.18
1–2 courses					1.59	*	.060	1.47-1.71	1.54	*	.059	1.42-1.66
Self-reported grade point average[3]												
A					1.57	*	.078	1.42-1.73	1.50	*	.076	1.36-1.66
B					1.31	*	.048	1.22-1.41	1.29	*	.048	1.20-1.38
NOCTI assessment score level[4]												
Advanced									1.39	*	.059	1.28-1.51
Competent									1.28	*	.071	1.15-1.43
Basic									1.00		.051	.91-1.11
Earned an industry certification									1.05		.056	.95-1.17
Likelihood ratio Chi-squared			293.92				1,555.34				1,638.51	
n=			17,703				17,483				17,319	

* Significant at the $p < .01$ level. [1] Omitted category: White. [2] Omitted category: No advanced STEM courses. [3] Omitted category: C or lower. [4] Omitted category: Below Basic. NOTE: Odds ratios are calculated by taking the natural antilogarithms of the logit coefficients to ease interpretation. Values exceeding 1 indicate increased odds of enrolling in postsecondary education, and values less than 1 indicate decreased odds. SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

The results of Model 3 suggest that students' technical skill levels are positively associated with higher education enrollment when controlling for a number of factors that have been found to influence higher education enrollment. The results suggest that, when compared to students who scored at the below basic level (the reference category), those at the competent and advanced levels were more likely to enroll in a postsecondary education institution within two to three years of graduation. By contrast, the odds ratio for earning an industry certification was not significant, indicating that those who earn an industry certification were no more likely to enroll than those without a certification after controlling for exam score. The results from Model 3 indicate that after controlling for race/ethnicity, gender, advanced science and math coursetaking, and GPA, the odds of an individual who scored at the competent level enrolling in higher education are greater by a factor of 1.27 than the odds for a student with a score at the below basic level. For those with scores at the advanced level, the odds of enrolling in a postsecondary education institution are greater by a factor of 1.39 than the odds of those with scores below the basic level.

The effects of race/ethnicity and gender in Model 1 indicate that the odds of enrolling are higher for Asians than Whites (the omitted category), and higher for women than men, findings which echo previous research (DiPrete & Buchman, 2006; Kao & Thompson, 2003). However, the odds of enrolling for Hispanics and Blacks are higher than those for Whites in Models 2 and 3, a finding that contradicts a number of studies on race and higher education enrollment (Kao & Thompson, 2003). This finding may be related to the limits of the sample (CTE high school graduates) or the outcome measure, which includes any postsecondary enrollment and not just those seeking a degree. These variables, and the measures of high school academic background added in Model 2, are significant in Model 3 and change little in magnitude with the addition of assessment score level and industry certification variables in Model 3.

Table 11 summarizes the results of the same models for the smaller group of about 3,000 high school CTE graduates who took a workplace readiness assessment. Model 3 includes the measures of technical skill while controlling for secondary academic background and demographic characteristics. As was found among students who took occupation-specific assessments, the odds of postsecondary education enrollment for students who scored at the competent and advanced levels are higher by factors of 1.70 and 2.22, respectively, than the odds of a student scoring at the below basic level. In contrast to the results for occupation-specific test takers, scoring at the basic level, relative to the below basic level, is also associated with postsecondary enrollment. The odds of enrolling for students scoring at the basic level are 1.42 time those scoring at the below basic level, net of the included academic background and demographic characteristics.

Table 11. Logit models of postsecondary enrollment among NOCTI workplace readiness test takers: 2005–2006 and 2006–2007

	Model 1			Model 2			Model 3		
	Odds Ratio	SE	95% CI	Odds Ratio	SE	95% CI	Odds Ratio	SE	95% CI
Ethnicity[1]									
Asian	1.09	.536	.41-2.86	0.94	.476	.35-2.54	1.05	.543	.38-2.89
Black	1.44	.240	1.04-1.99	1.59 *	.272	1.14-2.23	1.83 *	.319	1.30-2.58
Hispanic	1.19	.196	.86-1.64	1.30	.222	.93-1.82	1.43	.248	1.02-2.01
Gender (Female=1)	1.89 *	.141	1.64-2.19	1.82 *	.141	1.56-2.12	1.70 *	.134	1.46-1.99
Advanced (upper-division) STEM courses passed[2]									
3 or more courses				2.68 *	.269	2.20-3.26	2.27 *	.236	1.86-2.79
1–2 courses				1.16	.109	.97-1.40	1.07	.102	.89-1.29
Self-reported grade point average[3]									
A				2.00 *	.257	1.55-2.57	1.81 *	.237	1.40-2.34
B				1.24	.106	1.05-1.47	1.17	.102	.99-1.39
NOCTI assessment score level[4]									
Advanced							2.22 *	.249	1.78-2.76
Competent							1.70 *	.245	1.28-2.26
Basic							1.42 *	.185	1.10-1.83
Earned an industry certification							1.40	.231	1.01-1.93
Likelihood ratio Chi-squared		80.31			249.75			311.59	
n=		2,988			2,973			2,973	

* Significant at the $p < .01$ level. [1] Omitted category: White. [2] Omitted category: No advanced STEM courses. [3] Omitted category: C or lower. [4] Omitted category: Below Basic.
† Excluded from the analysis due to small cell sizes (less than 5). NOTE: Odds ratios are calculated by taking the natural antilogarithms of the logit coefficients to ease interpretation. Values exceeding 1 indicate increased odds of enrolling in postsecondary education, and values less than 1 indicate decreased odds. SOURCE: National Occupational Competency Testing Institute and PDE, Bureau of Career and Technical Education.

Earning an industry certification is not significantly related to the odds of enrolling in higher education in any of the models tested for students who took occupation-specific or workplace readiness assessments. As indicated in Appendix Table A5, about half of the certificates earned were for specific skills or sets of skills associated with the health professions, such as CPR or first aid. Although more information is needed, it may be that the certifications earned are associated with a number of occupations, some of which allow entry with a high school degree and others that require postsecondary training. It also may be that only certain types of certifications (such as certifications that test a range of skills) are associated with higher education attendance. The low percentage of students who earned an industry certification (about 10%) and the small number of different certifications earned mean that sample sizes are too small to explore outcomes by certification type.

The highest odds ratios among all the variables included in the model for students who took an occupation-specific assessment (but not in the model for students who took a workplace readiness assessment) are those associated with passing three or more advanced math and science courses. The results from Model 3 in both sets of models indicate that, after controlling for technical skill level, certifications, race/ethnicity, gender, and GPA, the odds of enrolling in higher education for a student who passed three or more advanced math and science courses are higher by a factor of 3.83 (among occupation-specific test takers) and 2.27 (among workplace readiness test takers) than the odds for a student who did not pass any of these courses. The direction and magnitude of these findings are consistent with previous research that found math and science courses to be among the strongest predictors of postsecondary enrollment and completion (ACT, 2009; Adelman, 2006; Miller, 2007).

As noted earlier, the test takers completed a variety of CTE programs and studied subjects as diverse as forestry, web page design, and dental assisting. It might be expected, given the different courses, skills, and employment and postsecondary education options associated with these programs, that the association between technical assessment score level and higher education would vary depending on the type of program in which the student enrolled. Appendix Tables 7.1–7.5 include descriptive statistics and the results of logistic regression models estimated for each of five subject-defined program areas: agriculture education; business/marketing and distributive education; health occupations education; occupational home economics education; and trade and industrial education.[29]

Overall, results similar to those found for the whole sample were found for each of the CTE program areas. The exceptions were agriculture education and occupational home economics education. For agriculture students (Appendix Table 8.1a), scores at the basic and advanced levels (relative to the below basic level) were positively associated with postsecondary enrollment relative to scoring at the below basic level, whereas a score at the competent level was not, when demographic and secondary schooling variables were

[29] The "other (not elsewhere classified)" category – which includes career exploration/awareness skills, diversified occupations, and vocational education, other – was not analyzed separately because a subject or occupational area does not unite the programs included in it.

held constant. The results for students who completed occupational home economics programs (Appendix Table 7.4a) indicate that scoring at any of the three passing levels (basic, competent, or advanced) increased the odds of postsecondary enrollment relative to scoring at the below basic level.

Conclusion

This study seeks to identify links between CTE concentrators' performance on NOCTI occupational competency assessments administered in Pennsylvania and their postsecondary education and early labor market experiences. In examining the extent to which students' test scores on these two types of assessments are associated with their post-program experiences, this study seeks to gauge the predictive power of occupation-specific and workplace readiness exams.

In designing the study, researchers selected Pennsylvania due to its commitment to technical skill assessment and the robustness of its education data: Today, nearly every student in the state who completes a CTE program sequence takes a standardized, state-recognized NOCTI competency assessment, and in the years examined in the study, over 80% of CTE program sequence completers took this assessment. Moreover, student employment follow-up data, collected annually using a standardized, online survey instrument, offers consistent information on the post-program workforce experiences of CTE concentrators graduating from a program. Finally, the state's subscription to the NSC supports the collection of postsecondary enrollment data for students entering public and private colleges and universities located across the country.

Data Quality

In attempting to assemble the database, researchers encountered a number of challenges that complicate statistical analysis. Although the state administered nearly 30,000 NOCTI exams to high school students completing a CTE program sequence across the 2005–2006 and 2006–2007 program years, PDE administrators were able to match test records with less than three-quarters (72%) of students' educational records. Although the unmatched records were likely random in nature, resulting from differences in how student names and other identifiers are recorded on NOCTI exams and represented in PDE administrative databases, the absence of more than one-quarter of student records calls into question whether study results are generalizable to all CTE completers. Low response rates on the statewide survey of CTE concentrators, in particular for students scoring at the two lowest score levels, also may overstate the post-program enrollment and employment outcomes of CTE concentrators.

Pennsylvania is taking steps to improve the match rate for students completing NOCTI exams by creating a unique student test identifier that will be incorporated into student education records. Although this will likely improve future data quality, challenges associated with creating a usable database for this study underscore that the state has not, to date, taken full advantage of the information contained in NOCTI test reports.

Measures of Technical Skill and Postsecondary Enrollment

Among the students for whom record matches were achieved, descriptive statistics indicate that those who score at the highest levels on a technical skills assessment were more likely to have taken a workplace readiness exam, to be female, and to be enrolled in a health occupations or occupational home economics program. Higher scoring test takers also were more likely to have completed three or more advanced math and science courses.

Multivariate analyses indicate that, when controlling for race/ethnicity, gender, advanced science and math coursetaking, and GPA, the odds of enrolling in higher education for a student who scored at the advanced level on an occupation-specific exam are greater by a factor of 1.39, and on a workplace readiness exam by a factor of 2.22 than the odds for a student with a score at the below basic level. For those with scores at the competent level, the odds of enrolling in a postsecondary education institution are greater by a factor of 1.28 for students taking an occupation-specific exam and by a factor of 1.70 for students taking a workplace readiness exam than for those with scores at the below basic level. No association was found between earning an industry certification and postsecondary attendance.

The highest odds ratios are those associated with students passing advanced math and science courses. The results indicate that, after controlling for technical skill level, certifications, race/ethnicity, gender, and GPA, the odds of enrolling in higher education for a student who passed three or more advanced math and science courses are higher by a factor of 3.83 for those taking an occupation-specific exam, and by a factor of 2.27 for those taking a workplace readiness exam than the odds for a student who did not pass any of these courses. This suggests that CTE concentrators taking both advanced academic and occupationally focused coursework may benefit from their studies.

Future Research

With additional data, the analysis presented here might be expanded in several directions and offer new insights into the association between students' technical skill attainment (as measured by technical skill assessments) and both postsecondary educational and labor market outcomes.

Recent changes in how Pennsylvania state data are collected have increased the amount of score information that Pennsylvania obtains from NOCTI. In 2008, the PDE arranged with NOCTI to report all test scores associated with a particular ID number.[30] The PDE provides funding to local districts for one technical assessment for each CTE completer or concentrator. In the academic years included in this study (2005–2006 and 2006–2007), only the score on the last technical skill assessment a student took was available for analysis. However, districts may also pay for a written pre-assessment, which is designed to be administered at the beginning of a program and assist in documenting

[30] Interview with Dr. Paul Munyofu, Research Associate, PDE Bureau of Career and Technical Education, July 20, 2009.

program gains. The PDE has developed a program to support CTE programs by using pre-assessments to identify students in need of extra assistance or remediation. About half of the students taking pre-assessments take them in the spring of their junior year, and the rest in the fall of their senior year.[31] The expanded data will indicate the extent to which districts use this option, and how this practice impacts student scores and outcomes. The use of a unique identifier rather than school and student names may also increase the number of NOCTI student records that can be matched to PDE data.

The opportunities for exploring the association between technical skill certifications and postsecondary outcomes are also likely to increase over time. The PDE Bureau of Career and Technical Education is working to increase the number of certifications earned by CTE secondary students. The list of recommended industry certifications also includes a number of certifications that measure skill sets (PDE, 2008). The list for health sciences, for example, includes BLS Health-care Provider, issued by the American Heart Association, which includes skills related to a number of health-care emergencies, and includes CPR and AED. Should the number of students earning these types of industry certifications increase, it would be worth exploring whether a student earning an industry certification associated with a particular set of skills is more likely to be employed or to enroll in higher education than a student with a more limited or no certification.

The high school curriculum program data used in this study were from the PDE's Bureau of Career and Technical Education's Secondary Career and Technical Education Information System (CATS) data system, and GPA was self-reported by the student when the NOCTI assessment was administered. Although the CATS system has detailed demographic data for students, the high school program data are more limited; for this study, the relevant variables were advanced courses passed and technical certifications earned. Linking these data with the state's K–12 data system could potentially provide more detailed measures, including cumulative high school GPA, individual course grades, and more detailed transcript information such as CTE courses taken.

Additional data on students' high school experiences would contribute to our understanding of the influence of program and school factors. CTE students in Pennsylvania attend courses either in comprehensive high schools offering CTE programs or in area CTE centers. Moreover, Pennsylvania CTE students have the opportunity to participate in tech prep and diversified occupation programs. Participation in specialized CTE programs has been shown to influence the likelihood of students entering postsecondary education (DeLuca et al., 2006) and may also affect technical skill levels.

A natural extension of this study would be to examine the relationship between technical skills and postsecondary outcomes with the additional postsecondary educational outcomes including first-year and cumulative GPA and graduation (Geiser & Santelices, 2007). Research on the postsecondary educational experiences of secondary CTE concentrators suggests, however, that outcomes for CTE students may differ from those

[31] Interview with Heidi Speese, Project and Account Coordinator, NOCTI, July 13, 2009.

associated with students who pursued a college preparatory track in high school. Recent research on the postsecondary transcripts of CTE concentrators indicates that they are more likely to attend a subbaccalaureate institution and to earn fewer postsecondary credits overall but more in career-related (CTE) courses than college preparatory concentrators (DeLuca et al., 2006; Laird et al., 2006). The findings suggest a number of other postsecondary outcomes, including type of institution attended, type of degree or certificate earned, and number of credits earned in CTE and other courses, that may be associated with a student's score on a technical assessment. Also of interest might be whether a student pursues a postsecondary program in a field related to their secondary CTE program.

Although postsecondary educational outcomes are increasing in importance as a measure of CTE program effectiveness, labor market outcomes are also of interest. Two outcomes that have been used in a large number of studies on postsecondary labor market outcomes include employment status and earnings (Griffith & Wade, 2001; Rose, 2006; Silverberg et al., 2004). Future research may focus on quantifying the association between students' performance on technical skill assessments, at both the high school and postsecondary levels, and their subsequent post-program employment results. Given the challenges associated with collecting valid employment data using traditional survey efforts, states may wish to consider identifying alternative sources of employment data—for example, by matching student records with state unemployment insurance records.

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