INSTITUTE FOR HIGHER EDUCATION
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THE ROAD LESS TRAVELED:

Realizing the Potential of Career Technical Education in the California Community Colleges

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February 2011

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Executive Summary

Potential of Career Technical Education Mission is Not Fully Tapped

The Career Technical Education (CTE) mission of California's community colleges is not well understood by policymakers in comparison to the transfer mission of the colleges. This exploratory study, to be followed by a more comprehensive research agenda, is motivated by the belief that CTE is a vital piece of the college completion agenda but is not receiving sufficient attention. While students can be successful in CTE in ways besides earning a certificate or degree, the issuing of workforce-related credentials is an undeniably important function of the colleges.

CTE is important to the college completion agenda because it can help California:

- Meet completion goals
- Meet workforce goals
- Meet equity goals
- Increase postsecondary productivity
- Realize benefits of high school reforms.

California is not yet poised to take full advantage of the potential of the CTE mission area because CTE is generally characterized by:

- A lack of priority across the system
- Weak credential structures and transfer pathways
- Underdeveloped data and accountability systems
- Higher costs that are not well addressed
- A lack of integration with core institutional operations.

There is solid evidence of good job prospects for students with certificates and associate degrees in career fields. Student interest in vocational coursework is high, with 30% of course enrollments in vocational courses. Yet of the more than 255,000 degree/certificate-seeking students in the 2003-04 entering cohort (defined as enrolling in more than 6 units in the first year), only 5% earned certificates and only 3% earned vocational associate degrees within six years.

Key Findings: Apparent Lack of Priority on Technical Credentials

As a basis for exploring CTE more generally, we studied patterns of student enrollment and progress in four high-wage, high-need pathways (information technology, engineering technology, engineering, and nursing), visited CTE programs, interviewed faculty and staff, and reviewed college catalogs and other materials. We know we can't generalize to all programs in all colleges, given the great variety in both, but the following findings strike us as important to any effort to understand and improve student outcomes in CTE programs.

1. **Data constraints limit knowledge and college actions.** The absence of provisions for students to declare a program of study seriously impedes efforts to understand and improve student success in CTE programs because it is difficult to know which students are pursuing which programs.

2. **Good student progress is not translating into credentials.** Few certificates and degrees were awarded despite considerable student progress. Far more students accrue 30 or more college-level credits and pass degree-applicable math than the relatively few who earn certificates or degrees. Additionally, more students completed at least 60 transferable credits than the number who transferred.

3. **Pathway structures do not promote attainment of technical credentials.** A picture emerged of CTE pathways that do not reflect a high priority on career-oriented credentials or on sequencing lower-to-higher credentials within a field. The route by which entering students are expected to attain the basic skills needed for their programs was unclear. There was no strong pattern of students attaining credentials in the chosen field of study, with the great majority of associate degrees in interdisciplinary studies rather than in a technical field. There is a huge variety of programs in some fields and an equally huge variation across colleges in unit and programmatic requirements for the same credential. Few students who transferred earned associate degrees and few who earned associate degrees earned certificates.

Recommendations: More Structure to Help Students Meet Career Goals

This study is the first stage of a broader research agenda aimed at understanding how state and system policies might best promote the success of students pursuing occupational programs. CTE is a richly complex mission area that we believe can benefit from more attention and greater understanding by policymakers and other stakeholders. We have much to learn from the work ahead, but this exploratory research, in the context of national momentum to increase structure and simplify pathways for students, leads us to make the following recommendations:

1. **Require students to declare a program of study and colleges to ensure access to programs**

   Having students formally select, and colleges provide access to, well-defined programs of study would have tremendous advantages for student success. Students would have a clear roadmap toward completion, colleges could better align the course schedule with student needs, and the means to monitor and improve program outcomes would be greatly enhanced.

2. **Consider fewer and more consistent program offerings**

   Hand-in-hand with requiring students to declare programs of study should be a commitment by colleges to ensure that the programs they offer are accessible to students and responsive to regional needs. The sheer number of and variation across programs lead us to question how students can navigate all of the choices and whether all programs "on the books" are still vital. Leading national researchers are calling for community colleges to review their multiple, variable program offerings to ensure they meet labor market needs, based on research findings that many choices and a lack of structure can deter student success.

3. **Focus on basic skills for CTE**

   The system's high-priority Basic Skills Initiative has not included an explicit focus on students in CTE programs and it does not appear to be serving CTE well. Few CTE students enroll in basic skills courses and many CTE faculty believe such courses do not benefit their students. Yet there is no systematic alternative for addressing basic skills deficiencies among students in CTE programs. Few certificate programs require English or math, raising the question whether they are producing graduates with the skills to succeed in the workplace. It is important that the system address basic skills for the CTE mission - both curricular requirements and means to help students meet them.

4. **Reexamine associate degree**

   The associate degree in California has been asked to serve the dual purpose of preparing students for transfer and for entry to the workforce. The passage of SB 1440 in 2010 is an acknowledgement that the current degree does not work well for transfer. But the degree may not work well for workforce-bound students either. Most degrees earned by students in the career pathways we studied were in interdisciplinary studies – a degree that does not signal to employers that a student has subject matter expertise in a field. As work begins to develop a new set of associate degrees for transfer, parallel efforts should examine how the existing associate degree might better serve students who are not intending to transfer.

5. **Conduct additional research**

   The data we reviewed raised specific questions that, if the Chancellor's Office could answer with additional research, would expedite efforts to understand and improve CTE outcomes. Why do students amass so many excess units along the way to earning certificates and associate degrees? What levels of math and English proficiency do and should individual certificate programs require? Are there sufficient opportunities for incoming students to receive knowledgeable academic and career advising about CTE program options? How many students satisfy certificate requirements but fail to officially earn one and why?

Strengthening the CTE mission area in these ways should yield substantial benefits for students, colleges, employers, and all Californians.

Acknowledgements

We thank the following individuals who reviewed and provided helpful comments on an earlier draft but, of course, we take responsibility for the findings and conclusions: Pamela Burdman, Darla Cooper, Hazel Hill, Davis Jenkins, Kelley Karandjeff, Nick Kremer, Jane Patton, Jessica Pitt, David Rattray, Barry Russell, Kim Schenk, Eva Schiorring, Bill Scroggins, Ron Selge, Vince Stewart, Chuck Wiseley, David Wolf, and the California Community College Vocational Research and Accountability Committee.

Career-Technical Education (CTE) and the Community College Completion Agenda

California, along with most other states, has made community college completion a major priority in the effort to boost educational attainment for broad sectors of the population and strengthen economic health. The research presented in this report is motivated by the belief that the career technical education (CTE) mission of California's community colleges is a vital piece of the college completion agenda but is not yet receiving sufficient attention. We are well aware that students succeed in CTE in ways that do not involve completing certificates or degrees. At the same time, the issuing of workforce-related credentials is an undeniably important function of community colleges. In this study we are interested in the CTE mission as it relates to completion of certificates and degrees.

While efforts to address student success and college completion are generally relevant to CTE, there are unique aspects of CTE that warrant more specific study. In this research we examine student progress through four career pathways as a basis for exploring more broadly how CTE can contribute to the college completion agenda. This report is the first part of a larger project to study whether state and system policies could better support student success in CTE programs. Although admittedly an exploratory study, our findings confirm our initial supposition that there is untapped potential across the system for CTE to better serve students and the state.

High Potential in the CTE Mission Area

CTE is important to the college completion agenda for the reasons described below.

Meeting Completion Goals

National college completion goals, such as those articulated by the Gates and Lumina foundations, include associate degrees as well as bachelor's degrees, and both foundations are investing in efforts to improve understanding of the role and value of certificates. The Obama administration, by calling for more Americans to get a year or more of college, also signaled the importance of postsecondary certificates. The report recently released by the California Community College League's Commission on the Future sets targets for increases in certificates as well as associate degrees.[1] Many associate degrees and most certificates are awarded in occupational fields, and there is evidence that the market value of associate degrees in occupational fields is greater than other associate degrees.[2] That finding is especially relevant amid the growing concerns that the completion agenda cannot just be about the number of credentials but must be about quality credentials with labor market value. Certificates, in particular, can reduce time-to-completion of a meaningful credential, removing a significant barrier to completion for the many students whose lives don't accommodate many years of college-going. Researchers have found that students with clear occupational goals are more likely to complete their programs of study,[3] suggesting that community college CTE programs can make important contributions to the completion agenda.

Meeting Workforce Goals

California faces a severe shortage of educated workers as the baby boom generation retires, the economy shifts to ever-higher dependence on high-level knowledge and skills, and the fastest-growing populations are not being educated at levels to fill job openings. Data confirm projected shortfalls in both jobs requiring a bachelor's degree and "middle skill" jobs requiring more than a high school education but less than a bachelor's degree (e.g., engineering technician, radiological technician, dental hygienist). A recent study found that California could have jobs for one million more bachelor's degree holders than the state is currently on track to produce.[4] Other research has documented that a large share of future job openings are "middle skills" jobs.[5] Clearly, more Californians with occupationally-oriented certificates and associate degrees are needed to supply the state's future workforce.

Meeting Equity Goals

Differential rates of completion across racial/ethnic groups in the California Community Colleges (CCC) present a severe social and economic challenge to California's efforts to increase educational attainment.[6] Structured career pathways that include certificates and associate degrees could be an important means to improve social mobility for economically disadvantaged Californians. Research suggests that high school students who take CTE coursework along with traditional academic courses have better employment outcomes, and at least comparable

postsecondary outcomes, compared to students taking only academic courses.[7] In the postsecondary arena, research suggests that there are economic benefits to low-income students who pursue longer-term certificates (30 or more units),[8] and that such programs can "lead to well-paid careers, particularly among low-performing students."[9] Students who earn credentials in occupational programs can have substantial earnings advantages over those earning traditional academic degrees.[10] Today's economy offers good-paying careers in many technical fields that don't require four-year degrees. Moreover, by one estimate 85% of occupational enrollments in community colleges are in fields that have counterparts in four-year colleges, raising the prospect of career ladders to higher paying positions if educational pathways are structured well.[11]

Increasing Productivity

Streamlining and strengthening career pathways can increase postsecondary education productivity. Poorly structured career pathways can result in students taking courses in pursuit of lower-unit credentials that don't count towards higher-unit certificates and degrees. This inefficiency in the accumulation of units has been well documented in the literature on community college transfer but may also be a factor impeding student movement from lower-unit certificates to higher-unit certificates and associate degrees. If relevant units don't carry forward to the next highest credential, the cost to the state and the cost to students in time and money increase. Additionally, CTE programs lend themselves to a cohort approach and to integrating basic skills instruction into the curriculum, both of which can contribute to increased rates of persistence and completion.[12]

Complementing High School Reforms

A growing body of research points to the benefits of multiple forms of career-oriented education in high schools and a growing body of practice is producing promising results.[13] Since community colleges serve the vast majority of California high school graduates who proceed to postsecondary institutions, strong career-oriented offerings that align well with those in high schools would optimize the benefits of high school reform efforts.

CTE Potential is as yet Unrealized

California is not yet poised to take full advantage of the great potential of the community college CTE mission area to help with the state's college completion agenda.

Lack of Priority

The legislature periodically reaffirms that the three core mission areas of the CCC are transfer, CTE, and basic skills education, yet the attention paid to the CTE mission has not matched that given the other two areas. Lawmakers express far more interest in and understanding of the transfer function, even though they know of the important contribution community colleges make to the state's workforce through career education. The Basic Skills Initiative, a top priority of the system for several years, has been pursued largely apart from the CTE mission. CTE programs are highly complex, as they often involve partnerships with state, local, and community organizations, have multiple funding streams, serve students with a variety of goals and prior experiences, and offer a wide array of certifications. Whether due to the sheer complexity of the mission area, the dominance of "academic" faculty in college leadership positions, or purposeful ordering of priorities by policymakers and the college system itself, CTE carries less status across the colleges.

Weak Credential Structures and Transfer Pathways

Despite the national research findings that certificates of at least one year and associate degrees in occupational fields have good economic returns,[14] such credentials appear to be undervalued in California. Relatively few students indicate a goal of earning a certificate or an associate degree and relatively few certificates and associate degrees are awarded. Many CTE students amass credits in career fields without acquiring a certificate or degree or they earn an interdisciplinary studies degree that does not reflect their field of study. The CCC does not differentiate *applied* associate degrees from associate degrees as is done in many states. The associate degree has been forced to serve a dual function but it has not served the transfer function well nor does it clearly signal career-relevant competencies. While the newly authorized associate degrees for transfer[15] are aimed to align a subset of associate degrees with transfer requirements, there has been no parallel

discussion of the need to retool existing associate degrees to better prepare students for the workforce and better communicate to employers the learning outcomes from associate degree programs.

Underdeveloped Data and Accountability Systems

Data and accountability systems are poorly suited to monitor progress and success within the CTE mission. The CCC system's Accountability Reporting for Community Colleges (ARCC) reports student success rates without accounting separately for CTE. The section of ARCC on vocational and career education reports only the *number* of certificates and associate degrees awarded by program area, providing no information about *rates* of student progress and success. Only certificates of 18 units or more are required to be reported, so there is no uniformity in reporting short-term certificates and no basis for determining the extent to which short-term certificates are earned as a step toward higher-unit certificates or degrees. This would be important data since research has failed to document economic returns to short-term certificates alone.[16]

There are two other major shortcomings of CTE accountability. First, systemwide data do not record the program of enrollment for students because, with a few exceptions like nursing, community college students in California *do not formally declare a program of enrollment*. Colleges report CTE outcomes to the federal government under the Carl D. Perkins Vocational and Technical Education Act but this is limited by the lack of data on program of enrollment. Student course-taking patterns rather than declared program intent is the basis for reported program outcomes. This method is unable to identify students until they are well along in their programs, and is thus more valuable for compliance with federal requirements than for informing college efforts to improve student success. Second, there is no systematic reporting of employment outcomes for CTE programs even though the purpose of most programs is to help students obtain paying (or higher paying) employment. Anecdotal reports that students get job offers or raises before earning a credential are sometimes offered as explanations for successful "non-completions" but lack rigorous labor market outcomes data by program to back up the claims.

Higher Costs Not Well Addressed

CTE programs tend to be more costly than other instructional programs. They are heavily dependent on equipment, many have class size restrictions due to access to equipment or specialized accreditation requirements, and they involve more frequent curriculum change as well as structured engagement with the employer community. The state funding formulas employed at most colleges do not accommodate these higher costs (even accounting for federal Perkins funds received for CTE programs) and CTE program administrators must seek external funding for what many would consider core instructional costs.

Lack of Integration with Core Institutional Operations

Finally, at many colleges CTE seems to operate quite separately from other instructional units, with separate administrative structures, less integration with core student support areas, and separate funding structures that leave CTE program administrators much more dependent on external resources to keep their programs operating. Efforts to strengthen CTE are generally undertaken as separate *projects* or *initiatives* apart from the state's multi-billion dollar investment in its community colleges – usually through grant application opportunities at local or regional levels that affect small numbers of students.[17] This lack of integration suggests that emerging efforts to address college completion could have less impact on CTE programs and student outcomes unless special care is taken to reduce "silos" that can interfere with college-wide planning for student success.

The Complexities of Studying CTE Student Success

Any effort to study student progress in CTE confronts a problem of language and definition. "Career technical education" has largely replaced "vocational education" as the term used to describe educational programs designed to prepare students for employment opportunities that do not *initially* require four-year degrees. Yet neither "career" nor "technical" helps us understand the distinct nature of these

community college programs. Many four-year programs are just as career oriented as are one- and two-year programs and many are highly technical. Some fields designated as CTE in the community colleges, like nursing, have well-established transfer pathways to universities and others do not. The Chancellor's Office data system classifies certain programs and courses as "vocational" for purposes of compliance with the Perkins Act but about 20% of the vocational courses are transferable and efforts are underway to increase the transferability of CTE coursework.[18] The term "sub-baccalaureate credentials" to reference certificates and associate degrees connotes something of lesser value and could impede efforts to strengthen these pathways into well-paying careers that are a prominent feature of today's economy.

While the nation could benefit from new terminology that better reflects the economy, which offers good technical career options at all levels of postsecondary education, we raise the issue here as context for our efforts to examine student success within the CTE mission. Our prior work has documented patterns of student success for all degree/certificate-seekers, but in this report we examine success in occupational programs specifically. We learned that both the definitions of CTE programs and the pathways along which one might measure progress are ambiguous. For example, we chose engineering as one pathway to study but wrestled with whether engineering technology and engineering are one pathway or two, and certainly between them they span the CTE and the transfer missions of the colleges. We chose nursing, which could potentially be the upper end of a career pathway that includes allied health fields, and which certainly encompasses the transfer function. We settled on four pathways (explained on page 9) that admittedly do not represent the full breadth of CTE offerings and consider the research merely exploratory and illustrative of issues that should be addressed on a larger scale.

Tracking student progress toward occupational program completion is complicated by variability in the value of certificates and degrees across occupations and by the different goals of the diverse populations that enroll in CTE courses and course sequences. Genuine questions have arisen, with respect to the national college completion agenda, about the wisdom of using the number of baccalaureate degrees as a measure of college success, irrespective of degree field and measures of degree *quality*. But with CTE we encounter more fundamental questions of whether and which credentials should be counted and how well a count of completed credentials measures the value of these programs. As examples:

- Associate degrees in some transferable technical fields lack or are perceived to lack market value, so many transfer-bound students do not bother to satisfy degree requirements.
- Many students earn an interdisciplinary studies associate degree that does not accurately reflect their occupational field of study, making it hard to define and monitor success in those occupational programs.
- Many CTE students are older, working professionals who need coursework rather than degrees, often for improved job security or advancement; many already have degrees (10% of the students who earned certificates in our study already had bachelor's degrees).
- There is a huge variety of certificates of varying lengths, many of which are shorter than the 30 units found by researchers as a threshold for economic return but may nevertheless have career advancement value for students, raising questions about which certificates should be counted as "completions."
- Some students are seeking industry certification and/or licensure as opposed to college-awarded certificates, outcomes that are not tracked by the colleges.

A Summary Look at CTE Enrollments and Outcomes

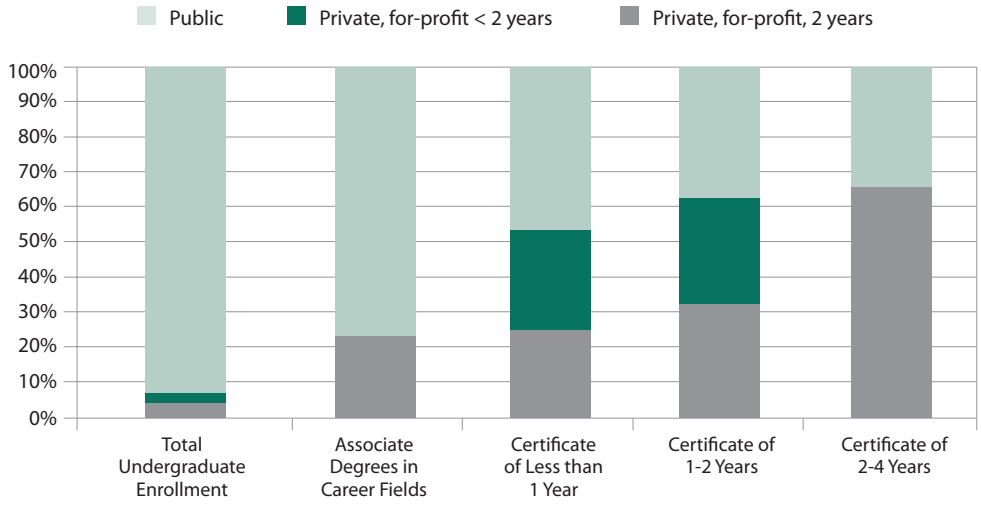
In spite of definitional issues and the challenges of studying student progress and completion, the importance of preparing Californians to fill good middle skill positions in the economy and to acquire the foundation for further education justifies the effort to understand these complex issues. To that end, we present some summary data as background for the analysis that follows.

Unlike the transfer mission of the colleges, the CTE mission area exists in a highly competitive arena in which for-profit institutions play a large and growing role. Figure 1 shows that while the for-profit sector enrolls fewer than 10% of all undergraduates in two-year (or less) institutions in California, it awards over 20% of the associate degrees in career fields[19] and between one-half and two-thirds of certificates. Figures 2 and 3 compare the career fields in which certificates and associate degrees are awarded by the for-profit and public sectors. Each graph shows the four largest program areas in that sector and, for comparison purposes, the share of awards in the other sector's top four programs. (Not shown in the for-profit graph is family and consumer sciences, which accounts for 11 percent of CCC awards but a negligible share at the for-profits.) Health professions account for the largest share in both sectors and business is also among the top four in each sector. While 91% of the awards by the for-profit sector are in four areas (health, mechanic and repair, business, and personal/culinary), those four areas account for only 55% of the awards by community colleges, which have a broader range of offerings.

Figures 4 and 5 present data on CTE course-taking, progress, and completion in the CCC. Figure 4 shows that nearly one-third of all credit enrollment in the community colleges is in vocational courses.

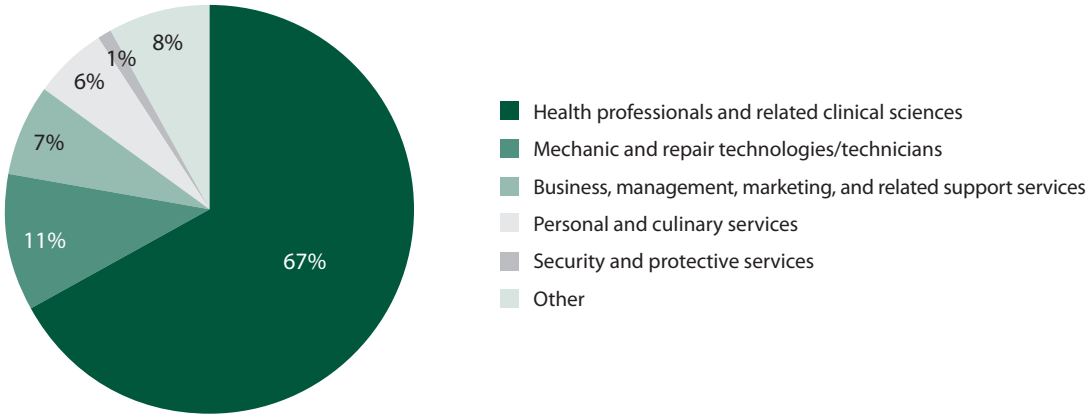
Despite these robust course enrollments, few students earn certificates or associate degrees in vocational areas. Figure 5 shows that of the 255,253 degree-seeking students entering the CCC in 2003-04, only 5% and 3%, respectively, had earned certificates or vocational associate degrees after six-years - far fewer than the share that transferred to a four-year institution. (We define "degree-seeking" as enrolling in more than six units in the first year.) Only 29% of all associate degrees awarded across the CCC in 2008 were in fields identified by the system as CTE, while 56% of all degrees

Figure 1
Share of Total Enrollment Compared to Share of Completion in Career Fields, For-Profits and Community Colleges in California



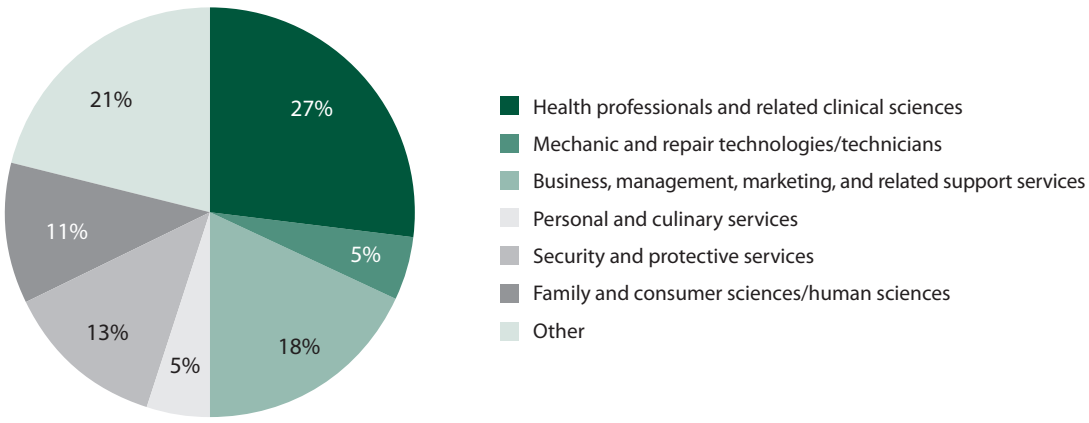
Source: The Integrated Postsecondary Education Data System (IPEDS). Survey year 2009.

Figure 2
Certificates and Associate Degrees Awarded in Career Fields by Private For-Profit 2-Year Colleges in California by Field



Source: The Integrated Postsecondary Education Data System (IPEDS). Survey year 2009.

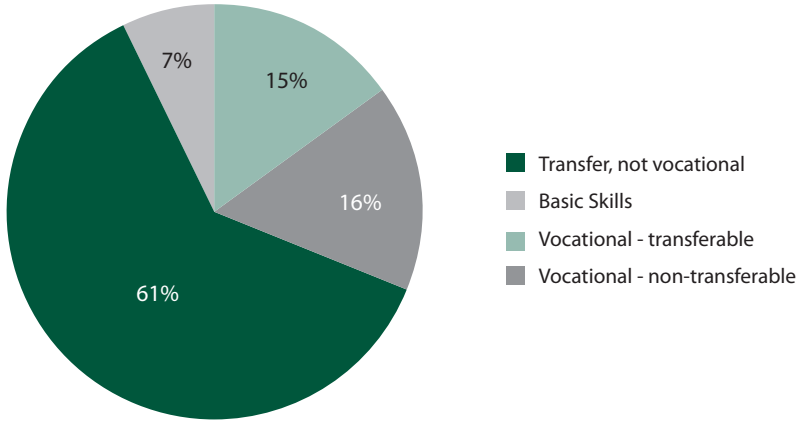
Figure 3
Certificates and Associate Degrees Awarded in Career Fields by Public 2-Year Colleges in California by Field



Source: The Integrated Postsecondary Education Data System (IPEDS). Survey year 2009.

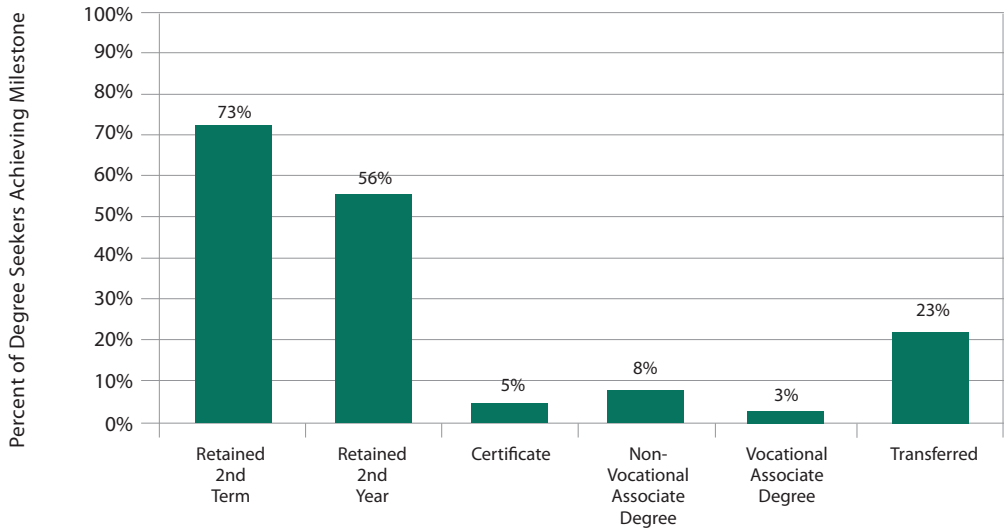
Career-Technical Education (CTE) and the Community College Completion Agenda

Figure 4
Distribution of Credit Enrollments, Fall 2009



Source: Community College Chancellor's Office Data Mart, reflecting the system's course classification definitions

Figure 5
Milestone Attainment within 6 Years among All Degree Seekers



Note: Students may be included in more than one completion measure as they could have, for example, earned both a certificate and an associate degree.

Source: *Divided We Fail*, IHELP, 2010.

were in interdisciplinary studies.[20] We know that these general purpose associate degrees don't serve students well in qualifying them to transfer as juniors into specific majors,[21] and this has been addressed through new legislation (Chapter 428, Statutes of 2010 - SB 1440) to develop associate degrees for transfer. We also suspect that they don't help students qualify for jobs in technical fields since they don't provide students with core content in a technical area or signal to employers what skills students have gained.

With nearly one-third of course enrollments in vocational courses and an economy that is growing more dependent on workers with technical postsecondary preparation, it seems reasonable to explore how students pursue and progress through CTE programs, why so few students earn vocational credentials in the community colleges, and whether community college programs are structured to meet student and employer needs. This report only begins to address these questions.

Research Plan

Our research methods were necessarily adaptive because of the fundamental data constraint of not being able to identify which CCC students are attempting to pursue which occupational pathway. Most students do not declare a program of enrollment so system data cannot track enrollment by academic program. We had to use course-taking behavior to judge which students were *likely* pursuing each pathway. The findings are necessarily less conclusive than our previous studies of student success where we did not try to draw any conclusions about specific academic programs. We take care to offer appropriate caveats in the presentation of our findings.

Our research involved the following steps:

1. **Select CTE pathways.** We selected four pathways that were of interest in their own right as high-wage, high-need fields, but primarily as a sample of the universe of CTE programs in order to learn more generally about issues of student progress and success in CTE programs.
2. **Learn about the pathways.** We studied the demographics and the enrollment patterns of community college students who completed programs in these four areas – those who had earned certificates or associate degrees at a community college or had transferred and earned a bachelor's degree at a California State University. This helped us know what patterns of progress and success to look for when we studied a new cohort of incoming students. In order to learn more about the pathways, we visited CTE programs at several colleges, conducted telephone interviews with CTE program staff and other experts, reviewed catalogs for 20 colleges of varying sizes and from different regions of the state to understand curricular requirements in these four fields, and reviewed published material.
3. **Learn about progress of students attempting the pathways.** As best we could, given data limitations, we applied the milestone and success indicator framework we have used in previous research[22] to learn where students may be encountering obstacles on the path to completion. We drew on the findings about completers (step 2 above) to determine what milestones and success indicators to monitor.

The remainder of this report describes these steps in order and offers findings and recommendations that are necessarily preliminary given the exploratory nature of this study.

Four Career Pathways – Setting the Stage

Choosing Pathways to Study

To select the high-wage, high-need, career pathways for study, we examined the *Occupational Employment Projections 2008-2018* of the California Employment Development Department to find fields with relatively high expected growth in employment and relatively high median wages.[23] We also examined data on the annual number of undergraduate certificates and degrees awarded by the CCC and California State University (CSU) systems in related programs.[24] Based on these data, as well as conversations with workforce and education experts, we selected four occupational areas for study:

1. Nursing
2. Engineering
3. Engineering technology
4. Information technology

Our focus on high-need, high-wage fields led to a selection of fields with more rigorous math and science requirements and more obvious opportunities at the baccalaureate level than is the case for many CTE programs. While this limits the ability to extrapolate specific findings to other CTE programs, examining student success in these fields may still serve as a foundation for a broader research agenda on the CTE mission of the community colleges.

Each of the fields includes a number of occupations. Nursing occupations include registered and vocational nurses and nursing assistants. Engineering includes the various subfields of engineering (e.g., electrical, civil) and engineering technology occupations include engineering technologists, drafters, and designers. We had originally grouped engineering technology and engineering into one pathway of engineering-related occupations, on the presumption that pathways might exist from engineering technology in community college to engineering at the university level. But our early research indicated that, despite similarities, the two disciplines function as separate pathways with different levels of foundational skills and little movement between the pathways. So we studied engineering technology as a separate pathway despite fairly modest growth and numbers of people employed. Information technology occupations include computer programmers, software and hardware engineers, network administrators, and various information technology specialists.

Description of Pathways

Nursing

There are four major nursing pathways in the community colleges:

1. Programs, typically certificates, that prepare students to become licensed vocational nurses (LVN)
2. Programs that prepare students for registered nursing (RN) and award an associate degree in nursing (ADN)
3. Programs that prepare LVNs for RN licensure
4. Preparation for transfer to bachelor's programs in nursing (BSN) at four-year universities; BSN students hold the same licensure as ADN students but take additional coursework in subjects such as public health and management.

Nursing programs generally admit students in cohorts that progress through coursework and clinical training on a full-time basis. Admission to an ADN program in the community colleges requires that students pass an entrance exam that tests skills in math, reading, English, and science. Students also have to complete prerequisite coursework prior to admission to the ADN program. Although prerequisite courses vary by community college, college-level English, microbiology, chemistry, human physiology, and human anatomy are common. There are fewer requirements for admission into LVN programs than for ADN programs. LVN applicants are not required to take an admissions exam (although they may have to demonstrate competency in math, English, or other subjects) and generally have fewer prerequisites. Although some community colleges offer programs that train LVNs to become RNs, articulation between LVN and ADN programs remains difficult because the programs have different prerequisites. The difference in prerequisites occurs both between programs offered in different community colleges and between programs in a single college or district.

Although some consistency is achieved through accreditation requirements, the lack of a statewide ADN curriculum creates articulation problems between ADN and BSN programs and has led to a system that requires program-by-program articulation. Through our interviews we learned that articulation problems are greatest between the community colleges and the CSU and University of California (UC). Students who

earned an ADN degree in the community colleges have an easier time transferring to BSN programs in private universities.

Engineering

There is one dominant pathway in engineering followed by community college students – transferring to a four-year university without earning a community college certificate or associate degree. Lack of alignment between associate degree requirements and transfer requirements is partly accountable for this pattern, as the heavy unit requirement for some majors does not fit well within the current associate degree format. (This should change under SB 1440, the newly passed law that requires development of associate degrees for *transfer* in specific disciplines.) In addition, there is little market demand for engineers with less than a bachelor's degree, reflecting licensure requirements. Consequently, while most colleges have engineering articulation agreements with universities, many lack formal engineering programs that confer associate degrees. Of the twenty colleges whose catalogs we reviewed, 11 offer associate degrees in engineering and two offer certificate programs. Students seeking to transfer in engineering, with or without the associate degree, take a heavy load of math and physical science courses, but fewer engineering courses, as most of those courses are taken at the university following transfer. As engineering fields become more specialized, evolving into different disciplines, transfer becomes more problematic. The choices are more difficult for students to navigate and the array of specialized course offerings are more difficult for community colleges to offer.

Relatively few associate degrees are awarded in Engineering compared to the number of colleges offering the degree, likely because students find they are better served by following individual articulation agreements for transfer requirements than by satisfying degree requirements. Most of the associate degree programs we identified were general engineering programs, suggesting that they may become even more under-subscribed as the field becomes more specialized. They were also extremely variable, ranging from 19 to 29 general education units and 9 to 53 major units. The new legislation authorizing associate degrees for transfer could change this situation dramatically. New engineering transfer degrees should be designed to ensure that students take an efficient route toward meeting lower division major requirements for transfer to CSU in their engineering specialty. Determining the core competencies for such two-year engineering degrees is a challenge facing the engineering field nationally.[25]

Calculus and physics are the gateway courses that students must pass in order to proceed to the subsequent set of calculus-based math and physics courses. These courses set this pathway apart from the engineering technology pathway.

Engineering Technology

There are two major pathways in the community colleges for students studying engineering technology:

1. Certificate and associate degree programs covering a set of entry-level technical skills, with the associate degree adding general education coursework to the technical courses that the certificate requires

2. Preparation for transfer into baccalaureate programs in engineering technology and related fields - fields less prevalent in the state's public universities than engineering but ones that are increasingly viewed as preparing important parts of the "engineering team."[26]

Students preparing for direct entry into the workforce may have more opportunities if they earn the associate degree because of the addition of the general education coursework, but the certificates and the degrees are both aimed at preparing students for the workforce and cover a diverse set of fields such as laser technology, mechanical drafting, and surveying. Of the 20 colleges whose catalogs we reviewed, 11 offer certificate programs and most of them offer more than one engineering technology certificate. One college offers 11 different certificate programs in engineering technology fields. We found a huge variety of certificate program lengths as well, ranging from 4 to 55 units of credit. Only 5 of the 36 certificate programs require a math course and none requires English. The associate degree – offered at 11 of our 20 sample colleges – falls under the systemwide requirements for English and math but beyond that, they exhibit significant variation as well, ranging from a low of 18 to a high of 35 general education units required and from 18 to 50 required major units.

Table 1 (top half) shows more specifically the variation we found across one particular certificate program in three

colleges in southern California. One college requires far fewer total units and, for the two colleges with the same unit requirement, specific requirements vary considerably.

Engineering technology coursework is rarely transferable to engineering because it is not calculus-based or sufficiently science-oriented. One program faculty we interviewed thought, however, that a curriculum could be designed to provide such a pathway. Transfer is possible into other four-year programs such as engineering technology, manufacturing technology, and construction management. The variety of associate degree requirements and an unsettled definition of a lower division engineering technology core amid rapidly changing fields, make it problematic for students to use the associate degree as a route to transfer eligibility.

Information Technology

In the area of information technology, there are three major pathways in the community colleges:

1. Industry certification, where students pursue coursework to prepare them for exams that lead to certification of skills by industry associations (e.g., Cisco Certified Networking Associate, Microsoft Certified Systems Administrator)

2. Community college certificate and degree programs covering a set of entry-level skills, with the coursework for a certificate often applicable to a related associate degree

3. Preparation for transfer into baccalaureate programs in computer science, computer engineering, or other IT programs.

Students intending to transfer generally do not seek an IT-related associate degree along the way, as the requirements for those degrees are not well aligned with the requirements for transfer. Those interested in industry certification may or may not seek a CCC certificate in the process (some colleges have certificates that consist of courses students would take to prepare for certification exams). In addition to these pathways, many students, including some who already have related degrees, take IT courses to upgrade specific skills, and others take courses to learn computer skills needed as part of non-IT certificate and degree programs. The wide range of roles played by the CCC in the IT area increases the complexity of understanding student pathways and student success in these programs.

Even for the pathways involving completion of a CCC credential, there is wide variation across the colleges in the types of certificates and degrees offered and the requirements to obtain them. Of the 20 colleges whose catalogs we reviewed, IT-related programs were offered at 19. On average, each college offered 7 different certificates and 3 different associate degrees, *but one college offered 28 different IT certificates and another offered 9 different IT associate degrees*. Certificate unit requirements also varied considerably, including, for example, an 8-credit certificate in Cisco Networking Associate and a 39-credit certificate in Computer Network Engineering. Fewer than 10% of the certificate programs require English or math courses. Associate degree program requirements for units in the major varied from 16 to 43 with comparable variations in general education requirements.

Table 1 (bottom half) illustrates the variation we found for one associate of science program in the IT pathway. Among three southern California colleges, there is considerable variation in general education requirements, number of credits required in the major, core course requirements, and the level of math required. The breadth and variation of program offerings, combined with the various pathways, suggests that it may be challenging for students to understand their options. The numerous short-term certificates offered also raises questions about market value given research demonstrating that workforce and economic benefits may only be associated with longer-term certificates of at least 30 credits.[27] Some colleges are moving to structure programs as a series of "stackable" short-term certificates to encourage completion, but that may prove to be a benefit only to the extent that completion of the shorter-term certificates actually encourages students to continue the program.

Our interviews and review of documents revealed several common issues confronted by colleges offering IT programs including the prevalence of math barriers, the challenge of professional development in fast-changing fields, limited adoption of new pedagogical approaches that may be more effective in engaging students, and employer opinion that such programs do better at providing technical skills than the business and project management skills employers value.[28]

Table 1
Certificate and Associate Degree Program Variability Across Colleges

Certificate: Drafting/Computer-Aided Design (CAD)		
El Camino College	**Citrus College**	**Santa Barbara City College**
31 credits ■ Intro to Mechanical Drafting ■ Wireframe w/Surfaces, Solid Modeling & Assemblies ■ Advanced Parametric Solid Modeling & Assemblies ■ Orientation to CATIA ■ Product Modeling w/CATIA ■ Analyses & Simulations w/CATIA ■ Adv. CATIA Functions ■ Geometrical Dimensioning and Tolerancing ■ 2-Dimensional Mechanical CADD I & II ■ Technical Mathematics	*19 credits* ■ Beginning Drawing ■ Digital Media Production I ■ Computer Aided Design and Mechanical Drawing OR Beginning Computer Aided Design (CAD) ■ Intermediate Computer Aided Drafting OR Introduction to Engineering CAD ■ Technical Illustration ■ Advanced Mechanical Drawing ■ Advanced Computer Aided Design and Drafting - Mechanical (CADD)	*31 credits* ■ Basic Drafting ■ Computer-Assisted Draft and Design I and II ■ 18 credits of drafting electives, up to 16 of which may be Work Experience in Drafting
Associate of Science Degree: Computer Science		
Glendale Community College	**Chabot College**	**Santa Barbara City College**
37 major credits *30 GE/other required credits* ■ Intro to Programming ■ Concepts of Programming Languages ■ Programming in C/C++ ■ Java ■ Computer Architecture & Assembly Language I & II ■ Data Structures I & II ■ Intro to Algorithms using Pascal ■ *Math required: Intermediate Algebra, Calculus optional*	*31-33 major credits* *19 GE/other required credits* ■ Intro to Programming Using Visual Basic.Net ■ Intro to Programming in C++ ■ Object-Oriented Programming in C++ ■ Java Programming ■ Intro to UNIX ■ Intro to HTML ■ *Math required: Statistics or Trigonometry, Calculus optional*	*40.5 – 45.5 major credits* *29-31 GE/other required credits* ■ Programming Fundamentals ■ Computer Concepts ■ C Programming ■ Java Programming ■ Intro to UNIX ■ Assembly Language Programming ■ Intro to Data Structures ■ *Math required: Discrete Math and Calculus I & II*

Four Career Pathways – What Can We Learn from those Who Succeed?

As an initial effort to learn about students in these four career areas and their progress along the educational pathway, we studied the patterns exhibited by community college students who successfully completed a postsecondary credential in one of these areas. There are limits to what can be concluded based on studying "successes" because there is no way to determine whether the patterns observed among successful students are any different from what we would observe among unsuccessful students (i.e., no way to conclude that the observed patterns were the reasons for the student's success). Nevertheless, we hoped to gather some initial information about the kinds of course-taking patterns students who succeeded had engaged in that might have helped to account for their success, information to be used in additional analyses and as the basis for interviews with subject-area experts. We examined data for all transfer students who earned a bachelor's degree from the CSU or a certificate or associate degree from a CCC in one of the four areas in 2007 or 2008 (see box at right).[29]

Figure 6 shows the total number of students studied by pathway and type of credential earned. The four pathways present an interesting variation in the mix of credentials. Engineering is almost exclusively a bachelor's degree field. While there were a small number of associate degrees

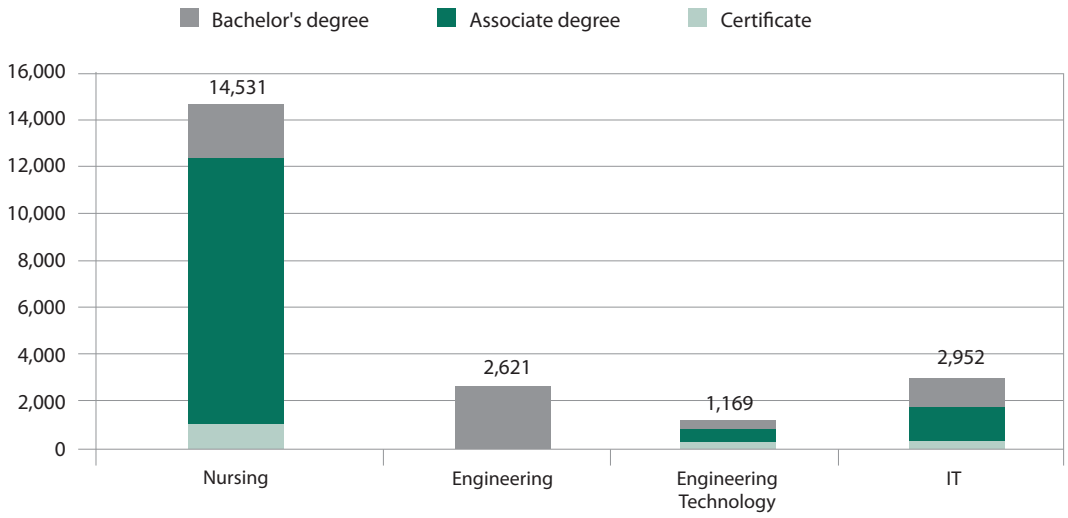
Data Used to Study Successful Certificate/Degree Earners

The CCC Chancellor's Office maintains student-level data for each college for each term with information on every course enrollment as of the census date, and certificates and degrees awarded. The CSU Chancellor's Office maintains student-level data for each university for each term including all degrees awarded by major field. We obtained two sets of data for the analysis of certificate/degree earners:

1. Records for all CCC students who earned associate degrees or certificates in one of the four pathways in 2007 or 2008. All of the course enrollments for these students, over whatever period of time they attended a community college, were included (records dated back to 1992-93). All certificates and degrees earned as of 2008 were included, although colleges are required to report only certificates of 18 credits or more, so shorter-term certificates are not fully represented in the data.

2. Records for all CCC transfer students who earned a bachelor's degree from CSU in one of the four career areas in 2007 or 2008. The CSU Chancellor's Office provided the relevant student identifiers to the CCC Chancellor's Office, which then provided all CCC records for those students (the same information as described in item 1 above).

Figure 6
Certificate/Degree Earners in the Four Pathways (CSU and CCC, 2007 and 2008)



awarded (imperceptible in the graph), nearly all completions in the field were bachelor's degrees awarded to students entering the CCC directly from high school and transferring to the CSU. The other three fields are a mix of credentials at all levels with the associate degree dominating the nursing pathway and engineering technology being the most balanced across the three credential levels. The mix of certificates, associate degrees, and bachelor's degrees across the four program areas allows us to explore pathway issues from certificates to associate and from associate, via transfer, to bachelor's degrees.

Demographic Patterns of Graduates

Table 2 shows demographic information about these certificate and degree completers, organized by the highest credential earned as of 2008 (students included in the group with an associate degree as the highest credential could have also earned a certificate at some point, and the CSU graduates could have earned a certificate and/or associate degree during their enrollment at the CCC). Among the interesting demographic findings:

Gender. There were significant gender disparities in these career pathways. A large majority of students earning certificates and degrees in nursing were female, while similarly large majorities of graduates in IT, engineering, and engineering technology were male. The gender gap in IT programs increases with each higher level credential.

Age. Students earning a certificate as their highest credential were more likely to be older at the time of initial enrollment in the CCC than students earning a degree. Most bachelor's degree earners entered the CCC shortly after high school graduation, especially those earning degrees in engineering, engineering technology, or IT.

Race/ethnicity. Black and Latino students were generally underrepresented among completers in these pathways compared to their shares of enrollment in the CCC, while white and Asian students were generally over-represented among graduates compared to their shares of enrollment. In general, the racial gaps in each field grow with progress along the educational pipeline, with smaller gaps at the certificate level and larger gaps at the baccalaureate level.

Table 2
Demographic Characteristics of Completers

	Highest Credential Completed		
	Certificate	Associate	Bachelor's
Nursing			
Gender			
Male	16%	16%	15%
Female	84%	84%	85%
Average Age at CCC Enrollment	25.9	24.2	22.7
Race/Ethnicity			
Asian	29%	28%	30%
Black	8%	6%	7%
Latino	26%	21%	18%
White	37%	44%	44%
Engineering			
Gender			
Male	-	86%	84%
Female	-	14%	16%
Average Age at CCC Enrollment	-	21.1	19.5
Race/Ethnicity			
Asian	-	15%	34%
Black	-	0%	4%
Latino	-	25%	21%
White	-	60%	41%
Engineering Technology			
Gender			
Male	85%	84%	90%
Female	15%	16%	10%
Average Age at CCC Enrollment	26.8	24.8	19.3
Race/Ethnicity			
Asian	16%	15%	18%
Black	6%	3%	1%
Latino	39%	30%	20%
White	38%	51%	60%
Information Technology			
Gender			
Male	72%	77%	87%
Female	28%	23%	13%
Average Age at CCC Enrollment	30.5	24.9	20.3
Race/Ethnicity			
Asian	24%	22%	34%
Black	7%	6%	4%
Latino	24%	20%	15%
White	43%	50%	46%

Four Career Pathways – What Can We Learn from those Who Succeed?

Course-taking Patterns of Graduates

In examining the course-taking patterns of graduates for signs of what might be important milestones and indicators of likely success, we found some interesting results that span across the four career areas:

Basic skills. Students completing certificates and degrees earned very few credits in basic skills courses (i.e., pre-college level courses), *an average* of only a credit or two. This tells us that a majority of graduates completed no basic skills courses.

Excess credits. On average, graduates had completed significant numbers of "excess credits," i.e., more credits than would have been required for the level of credential earned. The total number of CCC credits earned ranged from 60 to 80 for students earning a certificate as the highest credential, where the number of credits required would be 18 to 60 (with certificates of less than 30 credits most common). Associate degree completers earned an average of 90 to over 100 credits, while 60 credits are generally required. Those earning a bachelor's degree had earned an average of 80 to 90 CCC credits before transfer. While more research is needed on the reasons for so many credits, the patterns may suggest a need to simplify and/or clarify options for students through better advising, curriculum design, and/or course scheduling.

Technical coursework. As would be expected, the number of math and science courses taken increased with the level of credential completed. Also as expected, given the focus of transfer students on general education and lower-division prerequisites, students earning bachelor's degrees in these fields took substantially less major coursework in the specific discipline (i.e., engineering technology, nursing, IT) than did those earning certificates or associate degrees.

Pathway issues. Successful students navigated through a complex environment in which the pathway was more aligned at the certificate and associate degree levels:

- Associate degrees in these fields are not generally serving as a step on the pathway to a bachelor's degree. Among students who completed an associate degree before transferring to CSU, far more earned that degree in interdisciplinary studies than in a specific field. The exception is nursing, where about half of the associate degrees were in nursing. This is likely because many students who earned a bachelor's degree were practicing nurses who had earned an associate degree at an earlier point, and returned to college to get a BSN (a number of CSUs have specific programs designed for practicing RNs to get a BSN degree).
- A certificate in one of these fields is somewhat likely to serve as a step on the pathway to an associate degree, as about one-third to one-half of the associate degree earners had also earned a certificate, most in the same field. This was less the case in nursing, where the transition from a nursing assistant certificate to a degree in vocational or registered nursing is more difficult. Associate degrees in engineering technology and information technology are often specifically designed to layer general education coursework on top of the technical courses that count toward a certificate. We imposed no backward time limit for when a student earning an associate degree might have earned the related certificate, so some of these students may have earned the certificate well before they proceeded to the next credential level.

Questions Raised about CTE Pathways from the Data on Completers

Our analysis of the patterns among certificate and degree earners in these four career pathways raises a number of general questions about CTE pathways in the CCC.

Why have the students completing certificates and degrees in CTE areas earned so few basic skills credits? We know that a substantial majority of CCC students enter college with skills in English/Language Arts and/or math that place them below college level.[30] There would seem to be several possible explanations for finding so few basic skills enrollments among the completers:

1. A lack of requirement for math/English coursework (e.g., most certificates involve only technical coursework with no English or math course requirements, possibly allowing certificate-earning students to avoid basic skills courses)

2. A preference among CTE program faculty for addressing students' basic skills deficiencies in the context of the occupational curriculum over relying on the college basic skills offerings

3. A low rate of completion for students who enter the CCC with remedial needs. Certainly the amount of math and science coursework required for degrees in nursing, engineering, engineering technology, and IT could pose a challenge for students who enter the CCC without a good foundation in math skills.

In our site visits and our consultation with the system's Vocational Research and Accountability Committee, we learned that many CTE faculty do believe that students stand a better chance of persisting if they avoid regular basic skills sequences and learn requisite skills in their CTE coursework. A 2011 research study found better outcomes for CCC students who took contextualized developmental math compared to those in the basic skills math sequence.[31] Given the importance of sound basic skills for career and college pursuits and the very poor completion rates of students beginning in developmental math,[32] it is important to learn more about the degree to which basic skills are required in certificate programs and the extent to which skill deficiencies are impeding the completion of certificates and degrees, especially in high-growth fields such as the ones we have studied.

Why are so many students in technical fields earning their associate degrees in interdisciplinary studies?

We know that associate degree requirements are not fully aligned with the requirements for transfer, leading most transfer students to transfer without first earning an associate degree.[33] The transfer students who did earn an associate degree before earning their bachelor's degree in one of our selected fields mostly earned a degree in interdisciplinary studies rather than in their field of study. Most advanced occupational courses at the CCC are not transferable, so students intending to transfer focus on general education courses at the community college, saving the technical coursework for the university. Since the associate degree is not serving the transfer mission well, we might assume that the current set of associate degrees is designed for direct entry into the workforce. Yet we learned from interviews and other conversations that the associate degree in many technical fields does not have strong market value and does not give employers sufficient information about students' skills and competencies. *This raises the prospect that the current array of associate degrees may not be serving the needs of either transfer students or those seeking to go directly to the workforce.*

Does it serve students well to have so many different offerings of certificates and associate degrees within the same general field, and so much variation within and across colleges in subject matter and credit requirements for certificates and degrees in similar fields?

The considerable curricular variation we found across colleges could be an accurate reflection of the specialization within these fields. Alternatively, it could reflect some lag in curriculum planning by which emerging programs are added faster than lower priority ones are removed. If greater consistency is feasible, it could simplify the choices facing students and possibly reduce the excess credits that we documented among completers – especially at the certificate and associate degree levels. Additionally, more consistency across programs and colleges could send clearer signals to employers about the set of skills and competencies they could expect from a student with a given credential. That could, in turn, increase the market value of the credentials that the colleges offer but that are apparently not highly valued by students.

Four Career Pathways – What Can We Learn from Students Attempting these Pathways?

Identifying Students in Each Pathway

Building on what we learned from our interviews, literature and catalog reviews, and analysis of students who successfully completed a program of study in one of the four career pathways, we examined a cohort of first-time students who entered the system in the 2003-2004 academic year to learn about the patterns of student progress in and through these pathways (see box below).

Table 3 shows the number of students in each of the career pathways, as we were able to identify them with our criteria, and their demographic composition.

Data and Methods Used to Identify New Students Pursuing the Selected Pathways

We obtained a data set from the CCC Chancellor's Office that included all first-time students who entered the system in the 2003-2004 academic year and tracked them for six years through 2008-09.* The data included student demographic characteristics, all course enrollments, and degrees and certificates earned and transfers to a university.

Because the data do not contain information on program intent, we used enrollment behaviors as a proxy to identify students pursuing a degree, certificate, or transfer in one of the four areas of interest.** To limit our analysis to degree/certificate-seekers we selected students who enrolled in more than six units of any type in the first year, a criterion we have applied in other research. Guided by our analysis of course-taking patterns by completers, interviews with CCC faculty and administrators and other experts in these fields, and a review of program requirements as specified in a sample of college catalogs, we chose a set of enrollment behaviors that would best identify certificate/degree-seeking students in each pathway. We used multiple criteria to differentiate students in the targeted pathways from students in related pathways (e.g., identify nursing students but not biology majors).

* *Concurrently enrolled high school students and students enrolled only in non-credit courses were not included.*

** *See Appendix 4 in the online appendices at http://www.csus.edu/ihelp/pdfs/cte_web_appendix.pdf for the specific enrollment behaviors used to identify students pursuing one of the four fields of interest.*

Table 3
Characteristics of 2003-04 Cohort of First-Time CCC Students in Selected Career Pathways

	Degree-Seekers (>6 units year 1) (N = 255,253)	Nursing (N = 10,034)	Engineering (N = 4,350)	Engineering Technology (N = 1,381)	IT (N = 8,136)
Gender					
Male	47.0%	33.4%	55.7%	80.5%	69.1%
Female	53.0%	66.6%	44.3%	19.5%	30.9%
Age					
Mean	23.5	22.7	20.2	24.8	25.7
Race/Ethnicity					
White	39.2%	37.5%	43.1%	42.5%	39.2%
Latino	33.5%	22.4%	27.0%	38.2%	22.2%
Asian	17.7%	33.2%	23.7%	16.1%	30.1%
Black	8.6%	6.3%	5.3%	2.7%	7.9%

Milestone Attainment – How Far Do Students Get?

We used the milestone and success indicator framework that we have developed for previous research (see *Steps to Success, Divided We Fail*) to analyze student progress along the pathways and to determine whether certain enrollment behaviors were more predictive of student success. We included the generic milestones and success indicators that we have applied to all degree-seekers as well as ones that we developed specifically for students enrolled in the four pathways. Our findings come with a caveat due to the proxy method required to determine which students belong in each pathway (see box below).

Cautions Due to Proxy Method of Identifying Students in Pathways

To the extent that we have misidentified students in a pathway, our results would be skewed. For example, some students who failed to reach a pathway milestone (e.g., completing four nursing courses) may have faced barriers that would be important to understand; others who failed to complete those courses may not have been seeking a nursing credential. While we used course-taking behaviors as best we could to identify students in each pathway, the findings cannot be interpreted with the same level of confidence as our findings for the entire degree-seeking cohort, where it was not necessary to determine students' academic program goals.

The proxy method of using enrollment behaviors to identify students in pathways also likely overstates completion. We cannot recognize students as belonging to a pathway until they have achieved a fair amount of success, i.e., enrolled in the courses that we set as criteria for pathway status. We miss those students who intended to pursue the pathways but dropped out before enrolling in those courses. Our analysis is necessarily limited to those students who are further along and, therefore, more likely to be successful. In addition, the criteria applied to each pathway are different and therefore completion findings across the pathways are not meaningfully compared. For example, completions could look better in nursing than in IT because more students who intended to complete a nursing program dropped out before meeting the criteria for us to identify them as a nursing student than was the case for IT.

Figures 7 through 10 show the number of students who reached the intermediate milestones for each of the four pathways, as well as those who completed a credential or transfer.[34] The analysis shows that across all fields many students are lost before completing 30 college-level credits and many more are lost between completing 30 or more college-level credits and earning a certificate or degree or transferring. Math seems to be a more serious barrier for engineering and IT than for nursing or engineering technology, perhaps because of the higher levels of math required in engineering and because many IT students are returning adults who may have lost some of their math skills.

Specialists in each of these fields may find some specific patterns of note in the attainment of intermediate milestones. Here we point to just a few field-specific findings that suggest how such an analysis could help target efforts at key stall points – particularly with better data that allowed earlier and more accurate identification of students in the pathway.

- **Nursing.** Anatomy/physiology seems to be a bigger barrier than either math or chemistry, likely accounting significantly for low rates of completing all nursing prerequisites.[35] It is likely that our data reflect student failure to pass anatomy/physiology rather than their inability to enroll in the courses. Because we used enrollment in prerequisite courses to identify students seeking a nursing degree, most students that stopped pursuing a nursing program because they could not enroll in a prerequisite class were probably excluded from our analysis.

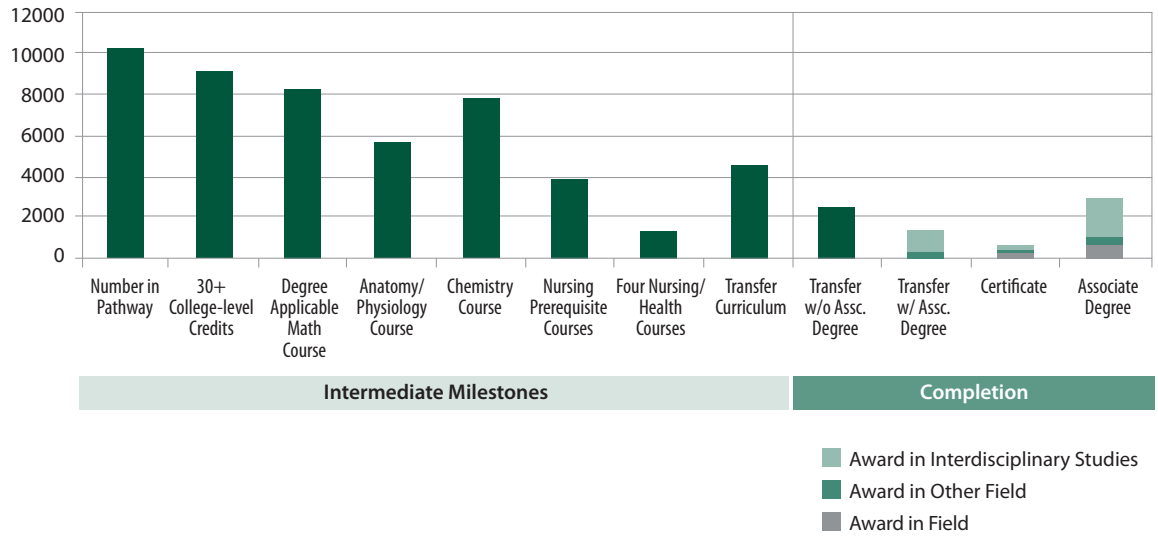
- **Engineering.** Math seems to be a bigger barrier than physical science.

- **Engineering technology.** No single barrier stands out, particularly as the drop off to the second year and beyond could be partially explained by students completing short-term certificates, which are a bigger portion of the completions in this pathway than in the others.

- **Information technology.** Math appears to be a significant barrier and few students persist to the point of completing four IT courses.

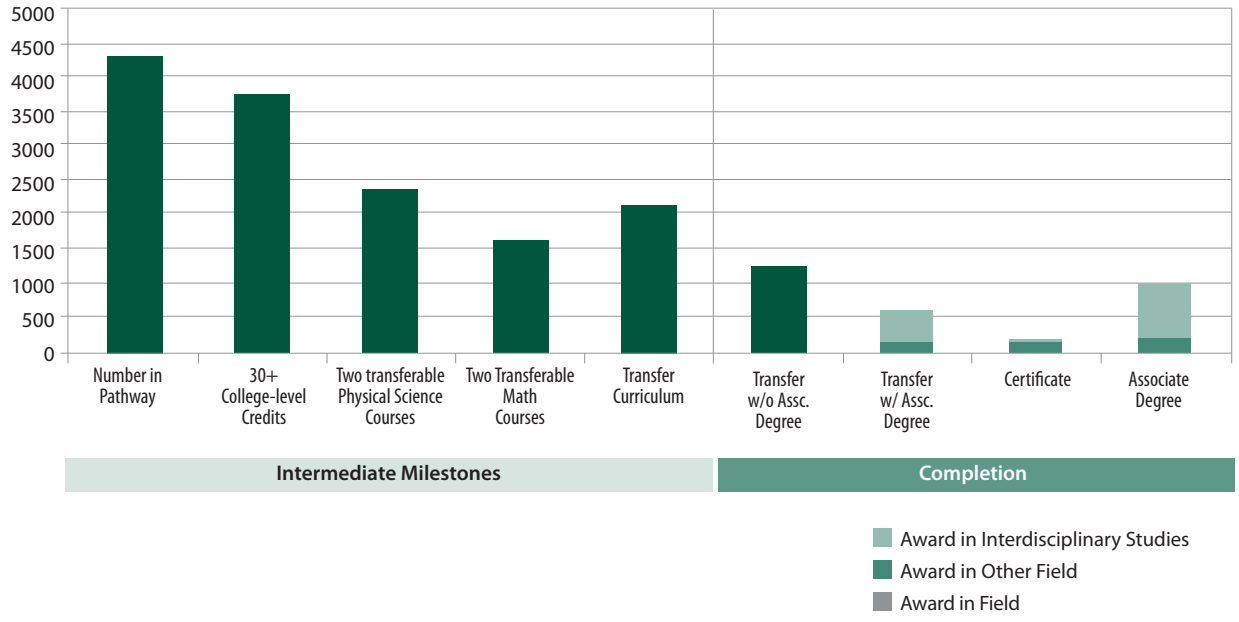
Four Career Pathways – What Can We Learn from Students Attempting these Pathways?

Figure 7
Milestone Attainment among Students in the Nursing Pathway



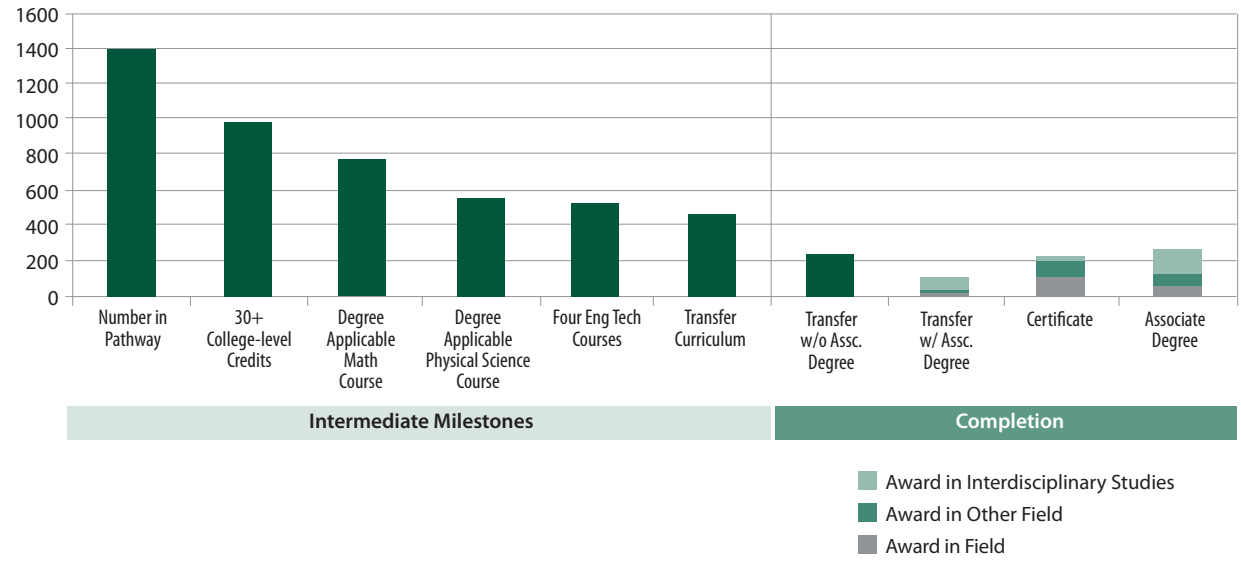
Note: Students can be counted in more than one category of completion, e.g., they may earn a certificate and an associate degree.

Figure 8
Milestone Attainment among Students in the Engineering Pathway



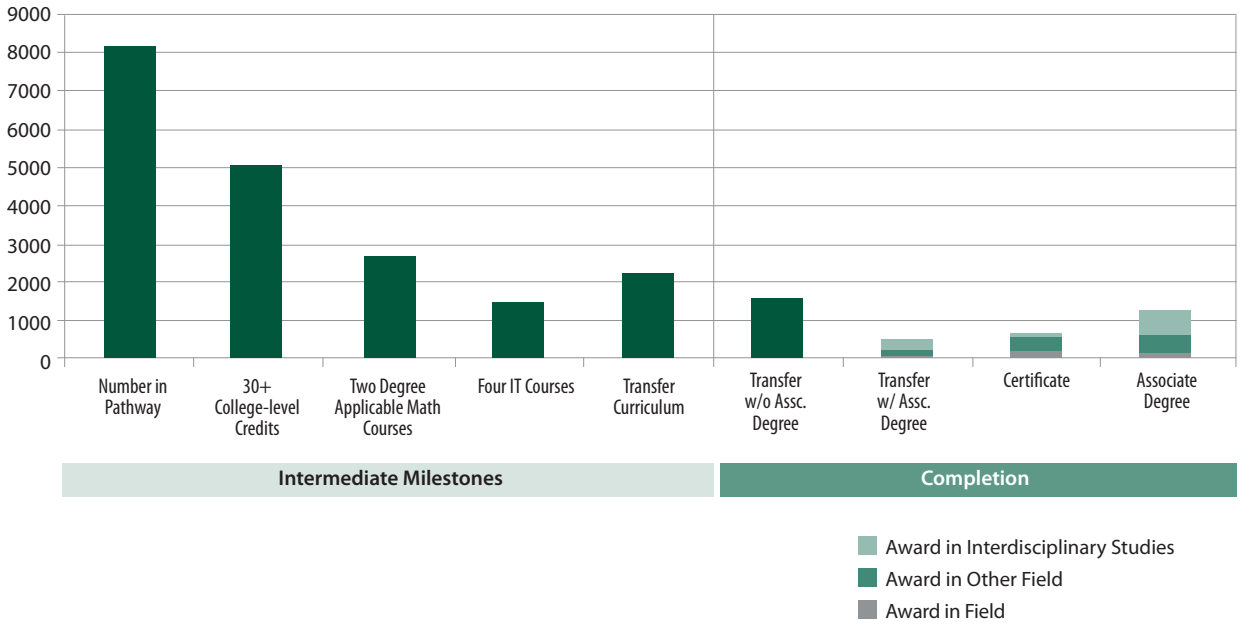
Note: Students can be counted in more than one category of completion, e.g., they may earn a certificate and an associate degree.

Figure 9
Milestone Attainment among Students in the Engineering Technology Pathway



Note: Students can be counted in more than one category of completion, e.g., they may earn a certificate and an associate degree.

Figure 10
Milestone Attainment among Students in the IT Pathway



Note: Students can be counted in more than one category of completion, e.g., they may earn a certificate and an associate degree.

Four Career Pathways – What Can We Learn from Students Attempting these Pathways?

Observations about Completions and Pathway Structure

The findings in Figures 7-10 show a generally low level of associate and certificate awards, particularly certificates, with the exception of the engineering technology pathway where the completions are more evenly balanced across transfer, certificate, and associate degree. The last three bars in each figure are intended to help us understand the extent to which there may be effective pathways from certificates to associate degrees to transfer in each field. Those bars show the alignment of degrees earned to the field of study.

Most certificates and degrees are outside the field of study. In all four pathways (Figures 7-10), the bottom slice of the associate degree and certificate bars – indicating those awards in the field of study – is the smallest. We assume that this partly reflects some misidentification of students in the pathway. Beyond that, we suspect that some of the "other fields" are closely related. For example, aeronautical and aviation technology, automotive technology, and electro-mechanical technology are *not* included in the engineering technology field (as we defined it based on Classification of Instructional Program [CIP] codes and the corresponding Taxonomy of Programs [TOP] codes used by the CCC[36]) but those fields seem closely enough related to suggest that more of the awards are reflective of a student's field of study than the graph suggests. It could also be that students struggle with the huge variety of certificate and degree programs offered (especially certificate) and the limited advising resources available at the colleges, and end up with certificates that don't best reflect their career intentions. Our finding that most associate degrees are outside the field (mostly in interdisciplinary studies – top bar in the figures) suggests that those degrees are not serving well those students who want to use their degree to enter the workforce in a technical field. Another possibility is that colleges do not have the resources to offer courses required for all of the programs in their catalogs. Students may end up earning awards in other programs or interdisciplinary studies because they are unable to find the courses needed to complete their intended program of study.

Most associate degree earners do not earn certificates. With the exception of engineering technology, many more students earn associate degrees than certificates during the six year period – meaning that the certificate does not function as a stepping stone for the majority of degree earners in the fields we studied, although some students who earned only a certificate within the six years could go on to earn an associate degree at a later point. However, the proportions of certificate and degree earners *within the field* is much closer, suggesting that when the associate degree is well aligned with the certificate – involving mostly the addition of general education – the certificate does function as a step toward a degree.

Few transfer students earn associate degrees; most degrees are outside the field of study. The majority of transfer students do not earn an associate degree prior to transfer and most of those who do, earn it outside the field of study. This is consistent with what we heard from those we interviewed and other research findings about the poor articulation between community college degree programs in career fields and the transfer requirements into four-year programs.[37] In particular, interviewees mentioned that students wanting a bachelor's degree in engineering are better served focusing on completing courses in math and science than by completing an associate degree in engineering. The finding that few transfer students earn associate degrees in the field validates the reform efforts that led to the passage of SB1440, since the current set of associate degrees is clearly not helping students achieve transfer eligibility in these programs.

Many students get close to transferring but don't transfer. In our report *Divided We Fail* we showed that fewer than half of all transfers complete a transfer curriculum prior to transfer, reflecting that many students transfer to private and out-of-state universities where there are fewer admissions requirements for transfer students. (We define completing a transfer curriculum as completing 60 transferable units including English and math). Here we see a very different pattern, with more students completing transfer requirements than actually transferring, across all four pathways. This suggests that many students persist

long enough to be eligible to transfer but don't have the precise course mix, a high enough grade point average to be accepted into high demand fields like engineering and computer science, or are unable to gain access to their program of study at their chosen college. Statewide efforts to improve transfer pathways, per SB1440, and to preserve transfer slots at public universities could have a major impact on increasing transfer numbers in these fields.

Success Indicators – Identifying Patterns that Help Students Succeed

An important part of our milestone and success indicator framework involves discovering what enrollment patterns are most predictive of success. Such information can help colleges direct efforts toward encouraging more students to follow successful patterns. Table 4 summarizes the success indicators that were most strongly associated with completing a credential or transferring to a four-year university. Students who met the success indicators shown had at least one-third greater odds of completing than those who didn't. Most of the indicators that we found to be important in our previous research on community college students in general were also important for students in each of the pathways.[38] This suggests that colleges should help students in CTE programs build early momentum towards completion and direct them immediately into any required English and math courses. Also shown are important success indicators that were specific to nursing, information technology, or engineering. The engineering technology-specific indicators that we tried were too weakly associated with completion for inclusion. The field-specific success indicators point to the importance of having students engage in substantive coursework in the field early on. Consistent with what we heard in our interviews, we found that nursing students who complete their science prerequisites when they first attempt them are more likely to complete. This suggests it is important to ensure that students are well prepared for this coursework so that they do not become discouraged by failing to complete it.

Table 4
Key Success Indicators

Success Indicators for All Pathways	Success Indicators for Some Pathways	Field-Specific Indicators
■ Complete college-level math in 2 years	■ Complete a college success course (engineering technology)	■ Complete a nursing course within 4 years (nursing)
■ Complete college-level English in 2 years	■ Register on time for 80% of courses (nursing, information technology, engineering)	■ Pass science prerequisites in first term attempted (nursing)
■ Earn 20+ credits in first year		■ Complete a physical science course in 2 years (engineering)
■ Complete summer credits	■ Enroll continuously (nursing, engineering, engineering technology)	
■ Complete 80% of credits in first year		■ Complete an IT course in 2 years (IT)
■ Attend full time in first term		

Findings and Recommendations: Realizing the Potential

The huge variety of CTE programs (especially certificate programs) and college circumstances require caution in generalizing too broadly from the four pathways we examined. For example, math requirements for the programs we studied are more rigorous and opportunities to transfer are greater than for many CTE programs. Recognizing that our findings and recommendations will not apply to all programs in all colleges, we conclude this exploratory study of CTE and student success by summarizing our main findings and offering recommendations. The unifying theme emerging from our research is that *there appears to be significant opportunity to better translate the credits that students earn into credentials that will help students attain their career goals.*

Findings

1. Data Constraints Limit Knowledge and College Actions

The lack of college and system data on student enrollment *by program* is a severe impediment to gaining a firm understanding of where students encounter barriers on the road to successful completion of degrees and certificates in CTE programs. The method we have used in the past to identify where students are getting stalled on the road to completion cannot easily be applied to individual CTE programs. With our "work around" method we were able to document some interesting patterns, raise some key issues, and draw some conclusions. But applying these analytical tools to *well-defined cohorts of occupational program enrollees* would be exceedingly more instructive. Program faculty and staff would be able to analyze in more detail, and with greater accuracy, where student progress was being stalled and would be more likely to develop appropriate responses.

Our analysis confirmed that the same behaviors we have found to be successful for all degree-seekers (e.g., enrolling full-time, passing gateway courses early) appear successful in these career pathways as well. We identified a few field-specific enrollment behaviors that appear to promote completion but having data to monitor students enrolled in specific programs would make this analysis far more powerful in identifying successful enrollment patterns for each field.

2. Good Student Progress is not Translating into Credentials

Despite data limitations, we were able to document significant student progress but relatively few certificates and degrees to show for it:

- **Low incidence of certificates and degrees**
  Few certificates and degrees are awarded relative to the number of vocational course enrollments (nearly one-third of all courses) and the needs of the California economy. We learned that associate degrees and certificates are not emphasized in some programs because such credentials are not believed to be valued by employers. We wonder if this is a "chicken or egg" issue. If occupational certificates and degrees sent clear signals to employers about the skills and competencies of the students who earn them, might employers value the credentials more than they do today? The national evidence of economic return to credentials of 30 or more units suggests that such credentials would be of value in California.

- **Significant threshold credit accumulation**
  Significant numbers of students in each pathway accrue 30 or more college-level credits and pass degree-applicable math - far more than the relatively few who earn certificates or degrees, suggesting unrealized market value. It would be important to know why students with 30 or more credits do not earn certificates. Possible explanations include: credits don't add up to meet any program requirements, students are unaware that they have completed a program, and students don't believe the credential will benefit them.

- **High transfer potential**
  More students in these career pathways complete a transfer curriculum than actually transfer - an opposite pattern from that exhibited by degree-seekers in general where most students transfer (other than to UC and CSU) without completing 60 transferable credits. This suggests that better structured CTE transfer pathways would be one change that could yield considerably higher transfer success.

3. Pathway Structures do not Promote Attainment of Technical Credentials

Several of our research findings paint a picture of CTE pathways that may not be structured to the best advantage

of students, because current structures reflect the lack of priority on career-oriented credentials.

- **Unclear basic skills needs and options**
  The core basic skills sequence does not appear to be serving CTE programs. Certificate/degree-earners in these four fields completed, on average, less than one course in basic skills. Several CTE program interviewees said they rarely refer students to basic skills courses for fear that the basic skills sequence is a dead end for their students. Yet despite individual reform efforts in math and language arts basic skills instruction across the CCC, there is no systematic alternative for addressing skills deficiencies in CTE programs. Few certificate programs even require English or math, which may not be in accord with the competencies employers seek.

- **Loose alignment of credentials with technical fields of study**
  Most certificates and degrees that were earned by the students we tracked were not awarded in the field of study as best we could define it. The great majority of associate degrees were awarded in interdisciplinary studies rather than in a technical field. Certificates were awarded in a wide variety of fields, some likely related to the pathway but reflecting a huge array of certificate programs across the colleges.

- **Substantial program variation and proliferation**
  We documented, and cited above, a huge variety of degree and certificate programs and an equally huge variation across programs in unit and programmatic requirements. Unit requirements, general education components, and basic skills expectations vary widely as well. With students needing (and asking for) fewer choices and more structure, and with employers and students likely benefiting from clearer signals from credentials, we question whether the copious array of offerings best promotes student success.

- **Pathways not designed around sequential credentials**
  Among the 2003-04 cohort we studied, few of those who transferred earned associate degrees and few of those who earned associate degrees earned certificates. Even fewer earned lower and higher credentials in the same field. Whether lower-unit credentials help students build momentum toward higher-unit credentials likely varies by field. Nevertheless, it seems important to understand whether more tightly structured pathways through levels of credentialing could promote student success.

Recommendations

1. **Require students to declare a program of study and colleges to ensure access to programs**
   All entering students who indicate a goal of certificate, associate degree, transfer, or job skills should be required to declare their desired program of study, including specific occupational program. This information should become part of the basic management information system (MIS), updated at least annually, to enable colleges to plan their course offerings around the programs in which students enroll. Students uncertain of their program should *initially* be "undeclared" and assisted to determine a programmatic intent by a certain point.

Having students formally select, and colleges provide access to, programs of study would have tremendous advantages for student success. Students would have a clear roadmap toward completion and have far fewer chances to make poor course-taking decisions.[39] Colleges could better construct a class schedule around programs (not courses) to ensure access to the courses students need. Excess units would be reduced, saving students time and money and providing capacity for additional students. Enrolling students formally in programs would give colleges a powerful data tool for improving student success. Our analysis, constrained though it is, has demonstrated the potential of the milestone and success indicator framework to help colleges learn how more students could successfully complete career programs. But more conclusive and helpful findings about student progress and success cannot be produced without accounting for enrollment by program.

2. **Consider fewer and more consistent program offerings**
   The Chancellor's Office should initiate an effort to review certificates and associate degree programs to determine whether student needs would be better met with fewer programs and greater consistency across colleges in program structure.

Findings and Recommendations: Realizing the Potential

Hand-in-hand with requiring students to declare programs of study should be a commitment by colleges to ensure that the programs they offer are accessible to students and responsive to regional needs. The sheer number of and variation across programs lead us to question how students can navigate all of the choices and whether all programs "on the books" are still vital. The excess units we documented among completers suggests that a condensed set of choices that reflects more consistency across colleges might be more efficient for students and taxpayers. A new report on certificate programs in the nation's community colleges documents the same complexity and variability that we found in California. It expresses concern about "the seemingly haphazard nature of the way that states approach certificate production" and speculates that the multiplicity and variability of offerings might have more to do with faculty interests and "the inertia of resource-allocation practices" than with labor market needs. Among that report's recommendations is that states collect and analyze data on labor market returns to certificates to ensure that the credentials offered have relevance to high-demand occupations and that state policymakers work with colleges to develop "more consistent certificate programs that encourage variations across colleges only as might be reasonably responsive to employers in the region."[40] Another new research report concludes that a lack of program structure can be a significant deterrent to community college student success.[41]

The new Course Identification Number System (C-ID) could aid efforts to achieve more consistency across CTE offerings. While some might argue that striving for consistency across program types and requirements would be contrary to the regional dimension of the CTE mission, there are examples of other large states with great regional variation that have more statewide consistency in their CTE programs. Community colleges in Florida, for example, must adhere to a state-defined set of content standards for each CTE program.[42] Each college can choose which programs to offer based on local needs and can decide how to organize its courses and curriculum to impart the standards to students.

3. Focus on basic skills for CTE

Current efforts to improve basic skills instruction should include an explicit focus on how students in CTE programs can best attain the proficiency levels in English language arts and math that their programs require.

This research raises a number of concerns about basic skills for CTE programs that warrant study. Our finding that CTE program completers in the four fields took virtually no basic skills courses raises the possibility that students are not able to overcome basic skills deficiencies to complete certificates or degrees in these vital fields. Some students are acquiring requisite basic skills in contextualized CTE curricula but such practices are not widespread.[43] Our finding that few certificate programs require English or math raises the concern that the programs are not producing graduates with the skills needed to succeed in the workplace. Given the importance of increasing student success in these, and other, key technical fields, it is important that as the system continues its priority work on basic skills, it explicitly address basic skills for the CTE mission - both curricular requirements and means to help students meet them - be it through contextualized instruction or basic skills courses.

4. Reexamine associate degree

As work begins to develop a new set of associate degrees for transfer, per SB 1440, parallel efforts should examine how existing associate degrees might better serve students who are not intending to transfer.

Our analysis confirms the need for the new associate degrees for transfer authorized by SB1440. It is difficult for one subject area associate degree to adequately prepare students to transfer into upper division coursework *and* prepare them with the subject matter expertise to move directly to the workforce. While a transfer degree need only prepare students with the introductory foundation to enter a bachelor's program at a par with other juniors, an applied associate degree must give students more substantive knowledge of the field as appropriate to entry-level job expectations. The associate degrees awarded by our colleges may not be meeting either of these needs well. SB 1440 offers a great opportunity to design degrees that will help students meet all lower division requirements and transfer as juniors into their major fields. But our analysis has convinced us that the current associate degree is also in need of review now that it will have a more singular purpose of preparing students for employment. Most degrees earned by students in the four career pathways were in interdisciplinary studies. A well-designed specialized degree

that gives students a clear roadmap of course-taking and gives employers a clear sense of the competencies of graduates might better meet students' short-term needs. Consideration should also be given to providing future transfer opportunities where there is a counterpart program in the CSU, perhaps via the "upside down" model whereby students complete most technical coursework at the community college and complete GE at the university.[44]

5. Conduct additional research

The data we reviewed raised some important questions that we believe the Chancellor's Office would be able to answer with additional research:

- Why do students amass so many excess units along the way to earning certificates and associate degrees?
- What levels of math and English proficiency do individual certificate programs require? Are these levels appropriate in view of employer expectations? How are basic skills deficiencies being addressed for students in CTE programs?
- Are there sufficient opportunities for incoming students – especially those coming directly from high school – to receive academic and career advising to help them understand available CTE program options?
- How many students satisfy certificate requirements but fail to officially earn one? Why?

Future Directions

We began this report by contrasting the importance of CTE with the position it currently occupies in the CCC. We hope that this study can help CTE gain a more integral position within the system, in terms of its priority, its funding, and the degree to which silos can be penetrated across mission areas.

As we build on these findings for our broader CTE research agenda, we will surely encounter many complexities and trade-offs. For example, how are employer needs best balanced with student needs in determining the amount of program differentiation and specialization within a field? Would there be an unacceptable cost in attrition of setting basic skill proficiency requirements for certificates? Would the addition of an *applied* associate degree help delineate pathways for students and employers? Would an *applied* baccalaureate offered by the California State University improve transfer outcomes for students in career programs or would it diminish the value of the baccalaureate? What is the best way, given scarce counseling resources, to help students declare a programmatic field of study in a timely manner? If some CTE programs are strictly "terminal" and others are highly transferable, should that difference be made more explicit for students and for the policies that pertain to CTE?

One potential trade-off strikes us as especially important to consider as we explore prospects for achieving better aligned career pathways. If we build cohesive pathways that lead from the certificate level to associate to transfer and a baccalaureate degree, there may be a cost of reduced success at the sub-baccalaureate level. For example, the level of math and science coursework required for vocational nursing is lower than that required for registered nursing, and the math requirements for certificates and associate degree programs in engineering technology are lower than those for transfer into baccalaureate programs in engineering or engineering technology. Increasing the rigor of requirements for the lower credentials would help students keep bachelor's degree options open but could discourage some students from pursuing what would otherwise be viable sub-baccalaureate career options, or could reduce their rates of success in those programs. At the same time, students who complete requirements for one level of credential and find that they want to continue their education could get discouraged if too few of their completed credits at one level count toward the next.

We will explore these and many other questions in the coming months and years as part of our broader agenda to understand how state and system policies affect the operation of the CTE mission and the success of students pursuing occupational programs. The goal of this research agenda is to help California adopt policies and invest resources to best promote the success of students in pursuing their chosen careers.

Notes

1 Lay, S.M. (2010). A *report of the Commission on the Future of the Community College League of California.* Sacramento, CA: Community College League of California.

2 Jacobsen, L. & Mokher, C. (2009). *Pathways to boosting the earnings of low-income students by increasing their educational attainment.* Washington, DC: Hudson Institute Center for Employment Policy and CNA Analysis and Solutions; Bailey, T., Kienzl, G, & Marcotte, D. (2004). *The return to a sub-baccalaureate education: The effects of schooling, credentials and program of study on economic outcomes.* Washington, DC: U.S. Department of Education.

3 Hagedorn, L.S. & DuBray, D. (2010). Math and science success and nonsuccess: Journeys within the community college. *Journal of Women and Minorities in Science and Engineering, 16*(1), 31-50.

4 Johnson, H. & Sengupta, R. (2009). *Closing the gap: Meeting California's need for college graduates.* San Francisco: Public Policy Institute of California.

5 Offenstein, J. & Shulock, N. (2009). T*echnical difficulties: Meeting California's workforce needs in science, technology, engineering, and math (STEM) fields.* Sacramento, CA: Institute for Higher Education Leadership & Policy; PolicyLink (2010). *Pathways out of poverty for vulnerable Californians: Policies that prepare the workforce for middle-skill infrastructure jobs.* Oakland, CA: Author; The Workforce Alliance (2009). *California's forgotten middle-skill jobs: Meeting the demands of a 21st century economy.* Washington, DC: Author; California Community College Association for Occupational Education (2010). *Proposed regional workforce and economic development strategy.* Retrieved from http://www.cccaoe.org/Splash/2010/Regional_Workforce_Economic_Development_Strategy_Overlay.html.

6 Moore, C. & Shulock, N. (2010). *Divided we fail: Improving completion and closing racial gaps in California's community colleges*. Sacramento, CA: Institute for Higher Education Leadership & Policy.

7 Stern, D. & Stearns, R. (2008). Evidence and challenges: Will multiple pathways improve student outcomes? In Oakes, J. & Saunder, M. (eds.), *Beyond tracking: Multiple pathways to college, career, and civic participation*. Cambridge, MA: Harvard Education Press.

8 Bosworth, B. (2010). *Certificates count: An analysis of sub-baccalaureate certificates*. Washington, DC: Complete College America (p. 23).

9 Jacobsen & Mokher, 2009 (p. i).

10 Bosworth, 2010; Furchtgott-Roth, D., Jacobsen, L., & Mokher, C. (2009). *Strengthening community colleges' influence on economic mobility.* Washington, DC: The Pew Charitable Trusts; Bailey, et al., 2004.

11 Grubb, W.N. & Lazerson, M. (2004). Community colleges need to build on their strengths. *The Chronicle of Higher Education, 51*(10).

12 Jenkins, D., Zeidenberg, M., & Kienzl, G.S. (2009). *Educational outcomes of I-BEST, Washington State Community and Technical College System's Integrated Basic Education and Skills Training program: Findings from a multivariate analysis* (CCRC Working Paper No. 16). New York: Community College Research Center, Teachers College, Columbia University; Scrivener, S., Bloom, D., LeBlanc, A., Paxson, C., Rouse, C.E., & Sommo, C. (2008). *A good start: Two-year effects of a learning community program at Kingsborough Community College.* New York: MDRC.

13 Farr, B., Bradby, D., Hartry, A., Sipes, L., Hall, L., & Tasoff, S. (2009). *Evaluation of the demonstration sites in the ConnectEd network.* Berkeley, CA: MPR Associates, Inc.

14 Jenkins, D. (2008). *A short guide to "tipping point" analyses of community college student labor market outcomes.* New York: Community College Research Center; Bosworth, 2010.

15 SB 1440 (Padilla), Chapter 428, Statutes of 2010.

16 Bosworth, 2010.

17 An example is the Governor's Initiative on Economic Development and Career Technical Education, SB 70 (Scott), Chapter 352, Statutes of 2005.

18 Course classification data retrieved from the Chancellor's Office Data Mart at http://www.cccco.edu/ChancellorsOffice/Divisions/TechResearchInfo/MIS/DataMartandReports/tabid/282/Default.aspx. The RP Group's CTE Transfer project is studying ways to improve CTE transfer pathways. Information on the project can be found at http://www.rpgroup.org/css/CTETransfer.html.

19 We identified career fields using the postsecondary taxonomy published by the National Center for Education Statistics (NCES). The NCES classifies programs as either career fields or liberal arts fields. The taxonomy can be found at http://nces.ed.gov/surveys/ctes/tables/postsec_tax.asp.

20 California Postsecondary Education Commission on-line data, *Degrees/Completions –Discipline/Instructional Program* for 2008, accessed December 10, 2010 at http://www.cpec.ca.gov/OnLineData.

21 For some of the reasons behind the new transfer legislation, SB 1440, see Moore, C., Shulock, N. & Jensen, C. (2009). *Crafting a student-centered transfer process in California: Lessons from other states*. Sacramento, CA: Institute for Higher Education Leadership & Policy.

22 Moore, C., Shulock, N., & Offenstein, J. (2009). *Steps to success: Analyzing milestone achievement to improve community college student outcomes*. Sacramento, CA: Institute for Higher Education Leadership & Policy.

23 See Appendix 1 in the online appendices at http://www.csus.edu/ihelp/pdfs/cte_web_appendix.pdf for a summary of the employment projection data for the four fields.

24 EDD produces occupational projections using Standard Occupational Codes (SOC). In order to identify educational programs related to each set of SOC codes, we used "crosswalk" files obtained from the National Crosswalk Service Center to match the SOC codes up to the Classification of Instructional Programs (CIP) codes used by CSU to classify their degree programs. To match CIP codes to the Taxonomy of Program (TOP) codes used by CCC, we used the *Crosswalk Table 6th Edition Taxonomy of Programs to 2000 Classification of Instructional Programs* obtained from the Chancellor's Office website.

25 Mattis, M.C. & Sislin, J. (Eds.) (2005). E*nhancing the community college pathway to engineering careers,* Washington, DC: The National Academies Press.

26 California Engineering Liaison Council (1995). *Engineering team.* Retrieved from www.caelc.org/#TEAM.

27 Bosworth, 2010; Leinbach, T. & Jenkins, D. (2008). *Using longitudinal data to increase community college student success: A guide to measuring milestone and momentum point attainment.* New York: Community College Research Center, Teachers College, Columbia University.

28 Association for Computing Machinery (2009). *Future of computing education summit.* New York: Author; Bullen, C.V., Abraham, T., Gallagher, K., Simon, J.C., & Zwieg, P. (2009). IT workforce trends: Implications for curriculum and hiring. *Communications of the Association for Information Systems, 24*(January), 129-140.

29 See Appendices 2 and 3 in the online appendices at http://www.csus.edu/ihelp/pdfs/cte_web_appendix.pdf for a list of TOP and CIP codes used to identify degree and certificate earners in these fields.

30 Legislative Analyst's Office (2010). *Are entering freshmen prepared for college-level work?* Sacramento, CA: Author.

31 Wiseley, W.C. (2011). Effective basic skills instruction: The case for contextualized developmental math. *PACE Policy Brief.* Berkeley, CA: Policy Analysis for California Education.

32 Wiseley, 2011

33 Moore & Shulock, 2010

34 See Appendix 5 in the online appendices at http://www.csus.edu/ihelp/pdfs/cte_web_appendix.pdf for a list of TOP codes used to identify degrees and certificates earned in these fields.

35 AB 1559, Berryhill, signed by the governor in 2007 requires community college registered nursing programs that use a multi-criteria screening process to admit applicants on the basis of a diagnostic assessment tool, academic performance, and other criteria. The use of these tools should increase the level of academic preparation among nursing students and the rate at which they complete their courses.

36 To match CIP codes to TOP codes, we used the *Crosswalk Table: 6th Edition Taxonomy of Programs to 2000 Classification of Instructional Programs.*

37 Schiorring, E., Karandjeff, K., & Cooper, D. (2009). *Phase I research summary: CTE transfer research project.* Berkley, CA. The RP Group Center for Student Success.

38 Moore et al., 2009

39 Scott-Clayton, J. (2011). *The shapeless river: Does a lack of structure inhibit students' progress at community colleges?* (CCRC Working Paper No. 25). New York: Community College Research Center, Teachers College, Columbia University.

40 Bosworth, 2010, pp.iii-iv and 26-27.

41 Scott-Clayton, 2011

42 Moore, C. (2010). *Strategies for improving higher education in California: Some lessons from Florida for California's higher education policies.* Los Angeles, CA: Campaign for College Opportunity.

43 Wiseley, 2011

44 Townsend, B., Bragg, D., & Ruud, C. (2008). *The adult learner and the applied baccalaureate: National and state-by-state inventory.* Champaign, IL: Office of Community College Research and Leadership, University of Illinois at Urbana-Champaign.

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The project is supported by a grant from
The James Irvine Foundation

The Institute for Higher Education Leadership & Policy seeks to enhance leadership and policy for higher education in California and the nation by producing research and services for policymakers, practitioners, and educators.

The Institute thanks the William and Flora Hewlett Foundation for its continued support.

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