




CTE Pathways to STEM Occupations

THE PROBLEM

U.S. employers are scrambling to fill jobs that are key to competing in the global economy. Many of these jobs—in computing, energy, manufacturing, and other fields—demand sophisticated STEM skills and knowledge, pay well, and require some higher education, but do not require a bachelor's degree. Some call these "middle-skill" jobs. Yet in *The Hidden STEM Economy*, Jonathan Rothwell suggests a more robust term, "high-STEM," for all occupations that require a "high level of knowledge" in any one STEM field.

Whether you call these jobs middle-skill or high-STEM, the reality is the same. As the number of new jobs that demand advanced STEM skills grows, there is a shortage of skilled workers. For the U.S. to remain competitive, business as usual will not work. The educational community and employers need to join forces to prepare an ample high-STEM workforce. Two undervalued key players—secondary career and technical education (CTE) and community colleges—will be instrumental in this effort.

Striking Statistics: The High-STEM Workforce—Status, Growth, and Gaps

- Over 50% of STEM jobs do not require a bachelor's degree, and almost 50% of students who receive four-year STEM degrees begin their learning at community colleges.[1]
- At all levels of educational attainment, people employed in STEM jobs earn 11% higher wages compared with their same-degree counterparts in other jobs.[2]
- U.S. Department of Labor projections show that 15 of the 20 fastest growing occupations require significant science or mathematics training to compete successfully for a job.[3]
- Educational institutions "are not on track to keep pace with" the growing need for Computer System Analysts, Web Developers, and several key Big Data occupations—all of which require extensive skills and knowledge, but not necessarily a BA.[4]
- In a National Association of Manufacturers survey, 67% of respondents reported that they do not have enough skilled employees—technicians, machinists, craft workers—and 56% reported this gap would grow through 2016.[5]
- Only 22% of the $4.3 billion in government funding spent on STEM education goes to "sub-bachelor's degree" education or training.[6]

> *"Workers in STEM fields play a direct role in driving economic growth. Yet, because of how the STEM economy has been defined, policymakers have mainly focused on supporting workers with at least a bachelor's degree, overlooking a strong potential workforce of those with less than a BA."* The Hidden STEM Economy

KEY ISSUES AND PROMISING PROGRAMS

This brief, the ninth in a series, explores issues and promising practices in paving CTE pathways to high-STEM occupations—a key piece of the STEM college and career readiness puzzle. Other briefs focus on related parts of the puzzle, such as the role that math and science standards play in students' college and career readiness, providing rich STEM learning in preschool and out-of-school time programs, and strategies to ensure all students enjoy a successful STEM education.[7]

Secondary Career and Technical Education

Secondary CTE can make STEM learning more meaningful and engaging through applied, student-centered approaches. These applied learning approaches help youth acquire key employability skills such as critical thinking, problem solving, collaboration, communication, and creativity.[8] When secondary CTE infuses applied STEM learning into rigorous programs of study, aligns with post-secondary programs, awards credentials, and offers dual enrollment programs that provide college credits, it propels youth toward college and career goals. Despite these strengths, CTE has received scant respect in the K–12 arena. In 2014, this is changing. Policymakers' interest and student enrollment in secondary CTE are both on the rise. Yet recent reports highlight potential obstacles to programs' ability to expand and enhance secondary CTE:

- The primary federal source of CTE funding, Perkins, is failing to keep pace with the demand to expand CTE and create new CTE programs of study relevant to STEM occupations. The recent FY 14 Omnibus Bill restored $53 million of the FY 13 sequestration cuts, but did nothing to restore FY 11 cuts ($140 million). With level or declining funding, this reflects a pattern of "erosion" in Perkins funds.[9]
- Findings from a survey of 850 secondary CTE educators offer a glimpse into current needs. Since 2008, program enrollment increased for 60% of respondents, while the budgets of 73% remained flat or decreased. Respondents' top priority for funds is not expanding programs, but attending to areas hit with deep budget cuts: equipment, professional development, technology, and curriculum. Nearly 60% reported they integrate academic learning into CTE, yet 70% said this integration is one-way; academic courses do not connect to CTE.[10]
- As noted on page 3, numerous reports point to the urgent need to build bridges between secondary and post-secondary CTE—through rigorous programs of study that integrate secondary and postsecondary curricula and shared standards (e.g., Common Career Technical Core), for example—to ensure a strong coherent continuum of STEM learning. Without such bridges, as the authors of one report note, "…many students earn college credit in high school that has limited value in the postsecondary space beyond a single institution of higher education."[11] Reports also underscore the need to improve professional development[12] and assessment approaches[13] to ensure youth are ready for post-secondary STEM learning.

Although these obstacles are formidable, a recent policy analysis conducted by the National Association of State Directors of Career Technical Education Consortium (NASDCTEc) and the Association for Career and Technical Education (ACTE) indicates that all but three states took legislative action to improve secondary CTE in 2013, and over 30 states invested new resources in secondary CTE. Eleven of the 30 states "addressed STEM in some way."[14]

In addition to state support, partnerships between STEM employers and community colleges offer a powerful mechanism to strengthen secondary CTE. Connections with STEM employers help secondary CTE teachers and programs keep abreast of changing workforce skill needs, enable students to explore careers, provide students with mentors and role models—as well as internships and externships—and deepen understanding of high-STEM occupations. Collaboration with community colleges helps create an aligned progression of learning that ensures students stay on track to meet their goals and fosters a skilled high-STEM workforce.

Promising Program—Innovation T-STEM Academy for Engineering, Environmental & Marine Science

Founded in 2009 in Corpus Christi, Texas, the Innovation Academy is a STEM program of study within Foy H. Moody High School that prepares students for STEM college and career success. Students enroll in the Innovation Academy through a lottery process that is based not on their academic achievement, but their interest in engaging in challenging STEM learning and exploring STEM careers. The Innovation Academy's four-year program includes upper-level STEM courses such as civil and architectural engineering, environmental science, aquatic science, and biotechnical engineering. All students take specific engineering, science, and math electives and carry out a Senior Capstone in Engineering Project. Depending on the pathways students choose, they can take Pre-AP, AP, Dual Credit, and Articulated college credit courses; students who complete the program can receive up to 30 hours of college credits. The Innovation Academy's diverse student population—96% from underrepresented groups and 86% from low-income families—outperforms students from the district in state assessments. Launched with grant funding, the Academy is now sustained through campus, district, and business partnerships—CITGO Petroleum Corp is a major partner—and is recognized as a model engineering high school by the National Project Lead the Way Engineering Program.

Community Colleges

In recent years, college and career readiness has, for many K–12 schools, families, students, and policymakers, come to mean a straight progression, first to college then career. Yet, an alternate trajectory—some post-secondary learning, employment and on-the-job-learning, then more post-secondary learning—benefits many students. This path can also help meet the urgent and growing demand for a high-STEM workforce. Community colleges are in the vanguard of guiding students through this alternate trajectory. These institutions help prepare an exceedingly diverse population of students for a wide array of careers, including high-STEM occupations, yet face complex challenges.

A 2011 NSF-supported National Academies Summit identified five challenges:[15]

- Overcoming students' inadequate academic preparation for STEM study
- Recruiting and retaining students in STEM education
- Creating and sustaining effective partnerships between two- and four-year institutions
- Finding the resources to support and sustain STEM education program improvement
- Aligning STEM education with workforce demands and practice

Other recent reports capture additional dimensions of community colleges' challenges, many of which involve alignment and strongly affect secondary CTE programs:

- NASDCTEc has identified a speed bump in creating a smooth learning progression and ensuring credit transfer for students moving from secondary to post-secondary CTE and from one community college to another. Only 13 states have state-approved postsecondary CTE standards (in contrast to 46 states with approved secondary CTE standards). Only *two* states have standards that are fully aligned between secondary and postsecondary CTE systems. [16]
- The National Governors Association (NGA) has issued an urgent call for governors to link STEM employers with colleges, pilot "new models of STEM education" in community colleges, reward colleges and students for "STEM course-completion," and support students' mastery of key mathematics skills—an obstacle to course completion. The NGA also suggests mandating that all community college credits and credentials be "stackable" (offer multiple entry and exit points while counting toward degrees), "portable" (count for credit at other institutions), and align with industry-validated certificates.[17]
- The Center for Law and Social Policy (CLASP) and Georgetown Public Policy Institute argue for stronger, more coherent systems—including data systems—to ensure all learners receive credit for rigorous post-secondary coursework, credentials, and training. Georgetown calls for the government to help CTE craft programs of study that are aligned across secondary and post-secondary levels to avoid duplication of coursework and ensure credit.[18] CLASP recommends the U.S. institute a national, "competency-based system for measuring learning and awarding postsecondary credit."[19]

Nationwide, initiatives funded by the NSF's ATE program and the Department of Labor's Trade Adjustment Assistance Community College and Career Training (TAACCCT) program are addressing some of these challenges. The ATE program is working to "prepare technicians for the high-technology workplaces that the United States needs to prosper." Thirty-nine ATE centers and many ATE-funded projects are using innovative approaches to tackle workforce preparation issues through strategic partnerships among K–12 education, secondary CTE, two- and four-year colleges, and employers.[20] TAACCCT grantees are using problem- and project-based approaches to create rigorous programs focused on high-STEM careers, engaging employers in program design, creating career-coaching systems, and helping students attain key mathematics and literacy skills (e.g., Massachusetts Community College and Workforce Development Transformation Agenda).[21]

Promising Program—Bellevue College, National Health I/T Technician

With NSF support, Bellevue College and the world's largest health information technology (IT) professional association, the Health Information Management and Systems Society (HIMSS), have developed a national entry-level technician certification to expand access to the field of health IT. The Certified Specialist in Healthcare Information and Management Systems (CAHIMS) addresses a serious and widening gap. The need for an IT workforce in health care is increasing, as the government funds electronic medical record adoption. Previously, no entry-level IT certification existed in health care, and CAHIMS illuminates a path into health IT careers. The certificate program is designed for emerging professionals with five years or less of experience, including community college and high school students, returning veterans, and people seeking a career change. It offers an overview of healthcare, health IT, and health information management systems, and is aligned to the Certified Professional in Healthcare Information and Management Systems (CPHIMS) certification administered by HIMSS. Those who complete the CAHIMS program and pass the exam receive a valuable, industry-recognized credential that qualifies them to facilitate and improve the quality of health IT and business management systems across healthcare settings and prepares them to pursue health IT careers.

STEM Employers

As the Department of Commerce notes in its report, *Good Jobs Now and For the Future*, "U.S. businesses frequently voice concerns over the supply and availability of STEM workers."[22] At the same time, reports highlight gaps between workplace needs and young adults' capabilities across U.S. industries.[23] For decades, the "career" part of college and career readiness has taken a backseat, and young adults and employers alike are suffering from its omission:

- Findings from a 2006 survey of 400 employers indicate that "professionalism/work ethic, oral and written communications, teamwork/collaboration, and critical thinking/problem solving" are essential to workplace success. The same survey found employers believe that many high school graduates lack these skills—and that graduates from two- and four-year college, while better prepared, are also deficient in essential skills.[24]
- Most recently, in a 2013 survey of 318 employers, 93% of respondents said that an applicant's ability to "think critically, communicate clearly, and solve complex problems is more important than their undergraduate major." Over 75% wanted colleges to place more emphasis on critical thinking, problem solving, communication, and "applied knowledge in real-world settings." And, 40% said colleges are only doing a "fair" job of preparing students for the workplace. [25]

Nationwide, there is a call for STEM employers to team up with K–20 educators to create clear, well-defined pathways to higher learning and workplace success.[26] By collaborating with post-secondary CTE and community colleges, in particular, STEM employers can help shape programs to ensure youth are ready for high-STEM occupations. Some employers feel they do not have a role to play. When asked "Who has primary responsibility for workforce readiness?," one survey of employers found that 76% felt that K–12 schools were responsible; only 19% felt employers were responsible, and 11% felt the business community was responsible.[27] In contrast, other employers are diving in to help by joining efforts such as Change the Equation, the National Network of Business and Industry Associations, and 100Kin10. And, nationwide there are examples of promising initiatives in which employers are engaging in partnerships

with secondary CTE and community colleges and providing innovative mentoring, on-the-job learning opportunities, and student and teacher externship programs.

Promising Program—Broadening Advanced Technological Education Connections (BATEC)

BATEC, the NSF ATE National Center for Computing and Information Technologies, seeks to transform IT education by encouraging educators and industry to support each other. In Boston, Chicago, San Francisco, and Las Vegas, BATEC is working to define, extend, and strengthen computing and IT pathways and career opportunities and facilitate strategic partnerships with education, business, government, and community to build awareness, generate interest, and support learning opportunities. BATEC uses a team-based approach to curriculum development that engages educators and industry partners in working together to explore emerging technologies. Advanced rigorous content is collaboratively created in response to current and emerging industry needs. In BATEC's instructional model, faculty employs a performance-based learning model that makes use of case- and/or problem-based methodologies. Students develop strong technical knowledge, combined with authentic critical-thinking and higher-order analytical skills that help empower and advance them in the workplace. BATEC's dual enrollment courses give high school students the chance to experience college classes and receive course credit. Its Tech Apprentice Program connects talented high school students with paid technology-focused internships in local companies, while college students gain experience and provide real value for small businesses and high-tech start-ups.

CONCLUSIONS

To foster a skilled high-STEM workforce, business, government, and education leaders must jettison old paradigms of successful STEM learning that focus on four-year colleges as the sole path to career readiness. Other routes—attaining some post-secondary training, entering the workforce, and continuing to pursue learning, credits, degrees, and/or credentials while on the job—are equally valid and important. It will require decisive action to realize the full potential of secondary CTE and community colleges in preparing students for college *and* careers:

- Create a strong, rigorous, seamless STEM learning continuum that is aligned across K–12 education, secondary CTE, community colleges, four-year institutions, and industry.
- Adopt, align, and implement common standards across secondary and post-secondary CTE to ensure that all learning is aligned, stackable, and portable.
- Draw on the active, applied learning strengths of CTE to spark students' interest in STEM, enable high school students to explore STEM careers, and increase the workplace relevance of four-year STEM learning.
- Ensure that all secondary CTE programs and community colleges have resources—including specialized equipment, educator professional development, and effective assessments—to provide the future high-STEM workforce with outstanding STEM learning.
- Explore options to retool key aspects of dual enrollment—including tuition and financial aid, high school-college partnerships, and articulation agreements—to make this beneficial program accessible to more students.
- Continue to look to STEM employers as a partner in ensuring programs reflect employers' evolving needs, strengthening programs, and scaling up effective new models.

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