CTE's Role in Science, Technology, Engineering and Mathematics

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BY ALISHA HYSLOP

For the last several years, concern has been brewing about America's underinvestment and underperformance in science, technology, engineering and mathematics—the fields collectively known as STEM. What is STEM, and why is it drawing so much attention? STEM can be described as an "initiative for securing America's leadership in science, technology, engineering and mathematics fields and identifying promising strategies for strengthening the educational pipeline that leads to STEM careers."[1] The elements of STEM are integral parts of our nation's critical economic sectors, from health care to energy, infrastructure and national security.

STEM careers include not only those requiring a research-based advanced math or science degree, but a broad range of related occupations in areas as diverse as aquaculture, automotive technology, accounting and architecture. More careers than ever before require a deep understanding of STEM principles. Unfortunately, the supply of STEM talent is not increasing to meet the growing need. Two main factors are affecting the supply side of the STEM equation. First, the looming retirement of the baby boom generation will significantly affect the STEM labor force. The number of current scientists and engineers retiring will increase rapidly over the next decade. Second, too few students are currently choosing to prepare for STEM careers. The United States is standing still or falling behind in terms of producing its home-grown STEM talent. At the same time, other nations, particularly population-rich ones like India and China, are rapidly increasing the number of STEM professionals that their secondary and postsecondary education systems produce.[2]

While some of the dearth of STEM professionals can be attributed to lack of interest, there is growing concern that students are not gaining the foundational skills necessary to be successful in STEM career areas even if they choose that path. Low student performance is evidenced on the U.S. National Assessment of Educational Progress. Math scores for 17-year-olds were significantly unchanged from 2004 to 2008, despite the fact that students are taking more and higher-level math courses in high school.[3] In fact, test results showed that 41 percent of those students did not even have an under-

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standing of moderately complex math procedures and reasoning, such as finding averages and making decisions based on graphs.[4]

According to the 2006 Program for International Student Assessment, American students performed much worse in science and math than students from other industrialized countries.[5] In addition, scores in the United States were much more closely correlated to socio-economic status than in other countries, and achievement gaps also exist among U.S. students based on race, ethnicity and gender.

CTE Provides a Solution

CTE has long been a leader in the integration of high-level academics and technology. For example, CTE courses in agriculture, nutrition and health care have always contained strong science components, in many places earning students core academic credits. During the last decade, however, literally thousands of new cutting-edge, STEM-intensive CTE programs have been launched or expanded in schools across the nation. As these programs move to larger-scale implementation, they have amazing potential to help many additional students prepare for and pursue careers in STEM areas. CTE programs and related initiatives provide key advantages in addressing the STEM challenge and securing America's leadership in innovation. CTE programs offer students a deeper understanding of STEM career pathways in order to facilitate student transitions into these areas, build interest in STEM and STEM-related careers by making math and science content more relevant and tangible to students through integration, and help grow the STEM workforce pipeline by encouraging more students from underrepresented populations to enter these career fields.

Providing Career Exploration and Pathways

There is a significant challenge in American culture of attracting students to actively pursue STEM careers. According to a recent survey about teen attitudes toward STEM, youths' lack of understanding of STEM creates a serious obstacle. "Nearly two-thirds of teens indicated that they may be discouraged from pursuing a career in STEM because they do not know anyone who works in these fields (31 percent) or understand what people in these fields do (28 percent)."[6]

CTE programs, integrated with active career exploration and career advising, help students understand the breadth of careers that have a relationship to STEM and the varied pathways that can lead to those careers. Courses in areas like aviation and aerospace, information technology, engineering, game design, health care, nanotechnology, and simulation and robotics expose students to curricula and careers they may have never even imagined. Embedded in CTE programs are the support services necessary to help students pursue these rigorous courses and career opportunities; these include mentors, Career and Technical Student Organizations, and work-based learning opportunities such as job shadowing and internships—which connect youth with caring adult role models.

Adding Relevance Through Integration

While most students have a strong aptitude for learning, their particular learning styles vary significantly. Many students may have difficulty grasping mathematical concepts and scientific theories if they are presented in an abstract manner devoid of clear applications. CTE courses deliver STEM content in a manner that is far different from the average academic course. Through the thoughtful integration of STEM concepts, CTE programs can help all students become more STEM literate, and increase the chances that these students will consider STEM-related careers. Examples of integration approaches include the "Math-in-CTE" project carried out by the National Research Center for CTE; the STEM Transitions Initiative, led by the Center for Occupational Research and Development and funded by the U.S. Department of Education; and the Ford Partnership for Advanced Studies (Ford PAS) curriculum modules, developed by Ford Motor Company Fund. State and local integration efforts are also under way all across the country. CTE courses demonstrate to students in a vivid way the direct applicability of STEM concepts in real-world applications, and show that these knowledge and skills have value in solving interesting and engaging real-world problems.

Encouraging Students in Underrepresented Populations

If the United States is going to successfully attract the number of additional students needed to pursue STEM-related careers, all population groups must be included in this effort—even those currently underrepresented in STEM areas. Females earn significantly fewer bachelor's and associate degrees in STEM fields like engineering.[7] African-American and Latino students, as a group, have significantly lower achievement levels in math and science and have been declining in the percentage of degrees earned in STEM fields.[8] These groups are key to the future of the STEM workforce, and CTE programs across the country are taking great strides in attracting them to STEM fields. To help increase the number of women in STEM careers, the Carl D. Perkins Career and Technical Education Act continues to require that CTE programs work to recruit students to programs considered "nontraditional," and holds them accountable for students' participation and completion rates. To encourage minorities to enter STEM career fields and better prepare these students to overcome current achievement gaps, CTE programs are expanding into urban areas and focusing on low-income and minority students. For example, in the Los Angeles Unified School District, a program funded by the National Science Foundation has focused on encouraging more students to enroll in computer technology programs.[9]

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Meeting the Challenge

In an always-growing, flattening, global economy, the United States is facing strong international competition in STEM areas. Fortunately, schools and colleges in the United States are rising to the challenge by offering rigorous, relevant CTE programs with content strong in science, technology, engineering and mathematics. The nation's economic leadership, inherently linked to STEM achievement, will not be maintained without support for critical CTE programs that build student interest and skills in STEM areas. Through the thoughtful investment in STEM-intensive CTE programs, America can readily increase its supply of motivated and prepared students entering STEM-related fields and strengthen the general STEM literacy of the emerging U.S. workforce.

Since 1997, when Project Lead the Way (PLTW) was launched as an independent not-for-profit organization with 12 high schools participating, PLTW's pre-engineering program has experienced rapid growth. By 2009, approximately 3,000 middle and high schools were participating in the effort, with 250,000 students enrolled in PLTW courses in engineering and biomedical sciences.[10] This is significant headway in reaching the goal of producing 400,000 scientists and engineers annually.

At Lake Travis High School (LTHS) in Texas, the PLTW curriculum is used as part of the Institute of Math, Engineering and Architecture. LTHS is using an integrated, cohort-based approach to implement PLTW and help more students explore careers in engineering. Ninth-grade students begin the program with the PLTW Introduction to Engineering Design course and continue with the 10th-grade Principles of Engineering course. During the sophomore year, these students take special, engineering-focused academic courses that help them see the relevance of traditional academics to their future career options.

For juniors, the coursework includes Digital Electronics, a course focusing on skills in basic electronics; logical thinking; problem solving and troubleshooting; and four articulated credits are offered at Austin Community College. Seniors complete the LTHS PLTW program with more in-depth elective engineering courses, as well as internships, capstone

projects and college connections. Much of the expansion and integration of the engineering program at Lake Travis has been made possible by a grant from Siemens Building Technologies. Siemens was looking for a school district to model and disseminate best practices in high school engineering programs.

Due to the highly recognized postsecondary engineering programs at Austin Community College and the University of Texas, Lake Travis was selected to participate. The grant has provided business and industry externships for academic and CTE teachers, common planning time to enhance curriculum integration, partnerships that connect students with the professional STEM community, and prepares them for postsecondary success across a wide range of career options. T

Endnotes

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This article summarizes the Association for Career and Technical Education's (ACTE) Issue Brief titled "CTE's Role in Science, Technology, Engineering and Mathematics." It was released in the summer of 2009 to capitalize on the national attention being paid to STEM fields and to position ACTE and career and technical education (CTE) as leaders in improving students' STEM achievement. ACTE Issue Briefs are designed to highlight the role of CTE in a broader issue of national interest. Each Brief is designed to strengthen the voice of CTE related to the specific issue and to draw more attention to CTE activities and best practices around the country. The Briefs provide background information, highlight research, profile CTE programs and include numerous examples of how CTE is tied to the broader issue. Issue Briefs are designed in a concise, easy-to-read format that is ideal for use in advocacy and public awareness efforts with a variety of audiences. The STEM Brief's complete text, including case studies and examples, can be accessed online at www.acteonline.org/issuebriefs.aspx.

Alisha Hyslop

is ACTE's assistant director of public policy. She can be contacted at ahyslop@acteonline.org.

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