

CTE Is Your STEM Strategy

INTRODUCTION

Science, Technology, Engineering and Mathematics (STEM) education is attracting interest across the nation. In many states, top policy leaders, including governors, K-12 chief state school officers and economic development commissioners, have made STEM central to their reform platforms. A significant number of states have STEM coalitions in place to coordinate all STEM activities across agencies and industries. Business leaders routinely call for more STEM-ready graduates broadly and within specific industry and specialty areas at the national, state and local levels.

None of this is very surprising or even very new. STEM has clear ties to and is a driver of economic development, global competitiveness and innovation. Students who understand the role of STEM and are able to excel in those courses and experiences anchored in the STEM disciplines are our future inventors, investors and industrialists. It is no coincidence that more than 20 percent of Fortune 500 CEOs have a background in engineering, the most common undergraduate major for these leaders.¹

While states, districts and schools strive to operationalize a concept like STEM, many already are offering high-quality Career Technical Education (CTE) programs that impart critical academic, technical and employability skills. More specifically, every state already has programs of study in place that are preparing students for careers in the STEM fields. These programs of study – which include learning at both the secondary and postsecondary levels – are also helping students master the STEM skills and competencies that have value in just about any career, such as inquiry, problem solving and creativity.²

To that end, this brief puts forth a not-so-novel concept: **CTE is your STEM strategy.** Simply put, STEM must not be viewed as a separate enterprise from CTE. While a state's CTE programs may not encompass everything within a state's STEM strategy, high-quality CTE programs can provide a strong foundation for and serve as a delivery system of STEM competencies and skills for a broader range of students.

By considering STEM as preparation for a variety of careers, and not just limited to the traditionally defined "STEM jobs," the strategy of leveraging CTE to deliver STEM education makes a lot of sense. While there is clear labor market demand for workers in STEM jobs – according to Change the Equation, there are 3.6 unemployed people for every job opening across all occupations compared to nearly two open STEM jobs for every unemployed person – the demand for STEM skills is even more comprehensive.³



According to an analysis by the Georgetown Center on Education and the Workforce, however, the STEM skills gap is actually more about a gap in those STEM competencies among workers than about a gap in the number of STEM workers. “The concern for STEM shortages tends to focus on the possibility of an insufficient supply of STEM workers, but the deeper problem is a broader scarcity of workers with basic STEM competencies across the entire economy. Demand for the core competencies is far greater than the five percent traditional STEM employment share suggests, and stretches across the entire U.S. job market, touching virtually every industry.”⁴

In addition, a recent report from the Brookings Institute estimates that as of 2011, 26 million U.S. jobs—20 percent of all jobs—require a high level of knowledge in any one STEM field, only half of which require a bachelor’s degree but nearly all of which pay well above the national median salary.⁵

One benefit of viewing STEM through this CTE lens is that it allows for a broader understanding of STEM, an understanding that extends beyond just engineering or the traditional science disciplines, which is how STEM is all too often narrowly defined and implemented. It also allows states, districts and schools to build their STEM strategies based on existing efforts rather than adding another new initiative to the mix.

The policy brief will explore:

- The elements of a high-quality CTE program of study that makes it an effective tool for delivering or implementing STEM education;
- How STEM is naturally embedded across the 16 Career Clusters[®];
- Examples of states embracing the link between CTE and STEM; and
- Areas where CTE and STEM programs can learn from and strengthen one another.

DEFINING STEM

There are many ways to define STEM education. For some, STEM is all about getting more students interested in and prepared for the engineering fields. Another common interpretation focuses on building applications within traditional science courses. The Next Generation Science Standards (NGSS), for example, offer this: “The [NGSS] represent a commitment to integrate engineering design into the structure of science education by raising engineering design to the same level as scientific inquiry when teaching science disciplines at all levels, from kindergarten to grade 12. There are both practical and inspirational reasons for including engineering design as an essential element of science education.”⁶

NGSS’s approach to engineering design is largely drawn from the National Research Center’s K-12 Framework for Science Education, which includes the following statement: “We use the term ‘engineering’ in a very broad sense to mean any engagement in a systematic practice of design to achieve solutions to particular human problems. Likewise, we broadly use the term ‘technology’ to include all types of human-made systems and processes. . . Technologies result when engineers apply their understanding of the natural world and of human behavior to design ways to satisfy human needs and wants.”⁷



Another definition focuses on the interdisciplinary opportunities within STEM: “STEM education is an interdisciplinary approach to learning where rigorous academic concepts are coupled with real-world lessons as students apply science, technology, engineering and mathematics in contexts that make connections between school, community, work and the global enterprise enabling the development of STEM literacy and with it the ability to compete in the new economy.”⁸ There is even a movement in place attempting to rebrand “STEM” into “STEAM” with the “A” standing for arts.⁹

CTE AS A STEM DELIVERY SYSTEM

In the spring of 2010, State CTE Directors from all 50 states united around a new vision for CTE, called “Reflect, Transform, Lead: A New Vision for Career Technical Education.”¹⁰ The vision sets expectations for CTE and promotes specific policy and programmatic action steps to achieve the vision and ensure CTE is high quality around the nation.

Specifically, five principles were identified in this CTE Vision:

1. CTE is critical to ensuring that the United States leads in global competitiveness.
2. CTE actively partners with employers to design and provide high-quality, dynamic programs.
3. CTE prepares students to succeed in further education and careers.
4. CTE is delivered through comprehensive programs of study aligned to The National Career Clusters Framework.
5. CTE is a results-driven system that demonstrates a positive return on investment.

All five of these principles directly apply to STEM, demonstrating a clear link between high-quality CTE and STEM policy, programs and initiatives. To go one level deeper, there are a number of elements within CTE that make it a natural delivery system for STEM education, discussed in more detail below. To be clear, these are elements of high-quality CTE programs, those meeting the principles laid out in the vision described above.

Secondary-Postsecondary Alignment

Programs of study, which are required for all recipients of federal funding through the Carl D. Perkins Career and Technical Education Act of 2006 (Perkins), incorporate well-aligned secondary and postsecondary courses, provide opportunities for dual or concurrent enrollment, are anchored in industry needs, integrate technical and academic knowledge and skills, and lead to an industry-recognized credential or postsecondary degree or certificate.¹¹

Programs of study provide direct pathways into postsecondary education and training for students, a critical goal of STEM education and the broader college- and career-ready agenda. Every state has programs of study in place, although in many states these secondary-to-postsecondary linkages are largely created and maintained at the local level rather than grounded in statewide standards or credit transfer agreements. A number of states do have robust pathway programs with strong articulation or transcripted credit policies in place,



such as Kansas's dual enrollment policy¹² or Montana's Big Sky Pathways initiative,¹³ that provide a model for other states. This is a policy lever that has significant potential to improve transitions for all CTE (and STEM) students.

Business-Education Partnerships

As articulated by the second CTE Vision principle, CTE is built on partnerships and sits at the nexus of education, business, and economic and workforce development. Successful CTE programs are well-aligned to industry needs, needs that can best be defined by industry leaders and employers.¹⁴

There are a number of models for engaging business in supporting CTE and helping keep it relevant, from business leaders sitting on advisory councils to providing work-based learning experiences for CTE students through internships, externships, job shadowing and capstone projects developed by business for business. Just as CTE programs thrive on business engagement, STEM programs also must reflect the expectations of employers and the global economy.

Problem-Based/Project-Based Learning

One hallmark of high-quality CTE is that it offers true "contextualized" learning for students, or ways for students to master technical and academic content within the context of a specific industry or career pathway. Much of this contextualizing is about providing students with more hands-on learning that focuses on solving a problem or undertaking a project that is reflective of an authentic, real-world challenge. High-quality STEM pathways and courses strive to provide such student-centered, problem-based learning as well.

The Southern Regional Education Board (SREB) is leading an effort with 10 states called Advanced Career. Through this effort, the states are each creating a four-course sequence in a CTE area of their choice, aligned to college- and career-ready standards and based on solving authentic problems. For example, Alabama is creating a sequence of courses and student-centered projects in Aerospace Engineering, Kansas in STEM Education and Training, New Jersey in Entrepreneurship and Global Logistics, North Carolina in Project Management, and West Virginia in Energy and Power.¹⁵

Additionally, many CTE students participate in Career Technical Student Organizations (CTSOs), such as FFA (formerly Future Farmers of America), HOSA (future health professionals), Technology Student Association and SkillsUSA¹⁶ which, among other activities, provide skills-based competitions for students. These competitions are based largely on students' abilities to work individually or in teams to solve problems and present projects to judges from industry and education. While the focus of these efforts is on CTE and career readiness, they clearly support student mastery of the "STEM competencies," as many problem- or project-based learning experiences do.



Use of Technology

In some states, such as Maryland and Oklahoma, CTE does not stand for “Career Technical Education,” but rather “Career Technology Education.” This demonstrates both the traditional view of CTE as a means of training individuals in technology (including, but not limited to, information technology) and the technical subjects, as well as a more updated view on technology as being critical and fully embedded in high-quality technical training. Indeed, one reason many states still utilize technology centers is that they allow schools to pool resources to make the necessary investments in technology and equipment, from pathway-specific software programs (e.g., AutoCAD, GIS, Photoshop) and hardware (e.g., fabrication tools, x-ray machines, power tools), to technology for project management and communications (e.g., Microsoft Office, Basecamp, WebEx).

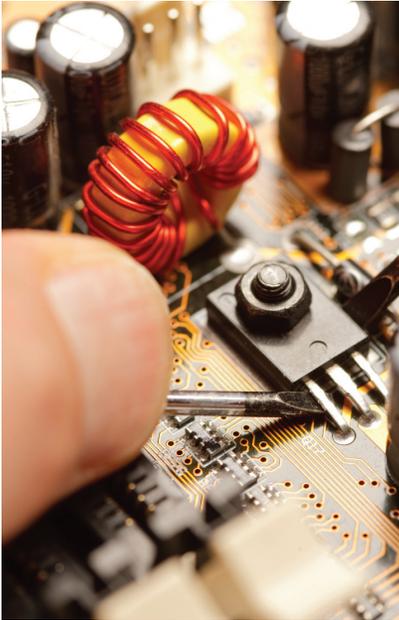
While states continue to grapple with how they can best leverage technology to inform and enhance instruction, CTE has embraced technology from the beginning. Given the expense of technology, many STEM programs can benefit from being integrated into CTE to utilize existing technologies and tools.

Integrated and Cross-Disciplinary Knowledge & Skills

As mentioned above, programs of study – or sequences of courses and experiences – are expected to integrate technical and academic knowledge and skills. Initiatives such as the National Research Center for Career & Technical Education’s Math-in-CTE and Literacy-in-CTE, Linked Learning, and the NASDCTEc-Achieve Task Alignment partnership¹⁷ are all examples of efforts to support the integration of academic and technical teaching and learning.

Additionally, with the Common Core State Standards in English Language Arts/Literacy, adopted by 46 states and Washington DC, CTE educators now have an explicit charge to bring rigorous, grade-level literacy into their courses. States also are engaging CTE educators around the Common Core State Standards in mathematics, although to a lesser extent to date. The NGSS, currently adopted by eight states, should also encourage more academic and technical integration by design, particularly with their inclusion of science and engineering practices.¹⁸

There is no question that, even without making the connections explicit, there is significant overlap in the knowledge and skills between traditional core academic courses and CTE courses. This is especially true given the increasingly demanding 21st century workplace, which requires more communications, analytical thinking and critical thinking skills than ever before. A benefit of CTE is that it can draw on knowledge and skills from any and all content areas. For example, themed career academies often require students to integrate the CTE area into all of their studies – and vice versa. The New York Harbor School, for example, integrates English, history, science and mathematics into and across its CTE-specific courses.¹⁹



Another way of considering integration is with respect to content and practices – or the integration of knowledge and its many applications. The Common Career Technical Core, a common set of CTE benchmark standards created by 42 states and two territories, introduce 12 Career Ready Practices which identify the knowledge, skills and dispositions all students, at all learner levels, need to have in order to be ready for careers.²⁰ It is clear that STEM can support and help foster all of these practices just as CTE does:

- Act as a responsible and contributing citizen and employee.
- Apply appropriate academic and technical skills.
- Attend to personal health and financial well-being.
- Communicate clearly and effectively and with reason.
- Consider the environmental, social and economic impacts of decisions.
- Demonstrate creativity and innovation.
- Employ valid and reliable research strategies.
- Utilize critical thinking to make sense of problems and persevere in solving them.
- Model integrity, ethical leadership and effective management.
- Plan education and career paths aligned to personal goals.
- Use technology to enhance productivity.
- Work productively in teams while using cultural global competence.

Access for Typically Underrepresented Students

A common concern about America's ability to compete globally in the STEM fields is that too few minority students have access to and are prepared for STEM careers (or the postsecondary education necessary for access to STEM careers).²¹ However, CTE is slightly more diverse than the full population of secondary students, providing an entry point and introduction to STEM competencies and skills for more traditionally underserved students, as demonstrated in Table 1.

There are two likely explanations behind the data. For one, "vocational" education was typically a separate (and unequal) track for students who weren't "college material," into which certain disadvantaged students were counseled. In the last decade, CTE programs have embraced the goal of preparing students for careers rather than for specific jobs, and efforts are being made in many states and districts to ensure CTE pathways are equally rigorous to more traditional course pathways. The second explanation is simply that CTE is relevant and interesting (i.e., utilizes hands-on learning, technology and interdisciplinary lessons), thus attracting students who may be marginalized in traditional education. In any case, CTE presents an opportunity for engaging more students into STEM careers.

One group making the connection between STEM and CTE is the National Alliance for Partnerships in Equity (NAPE), a coalition of organizations working to ensure gender and racial equality in classrooms and the workplace. NAPE is leading an initiative called STEM Equity, which specifically works to improve opportunities for underrepresented populations in STEM "including STEM-related Career and Technology Education."²²



Table 1: Enrollment in CTE by Race/Ethnicity²³

<i>Race/Ethnicity</i>	<i>% of Total 9-12 Enrollment</i>	<i>% of Secondary CTE Participation</i>
ALL.....	100%.....	100%
American Indian/Native American ²⁴	1.2%.....	1.2%
Asian/Pacific Islander/Native Hawaiian.....	5.1%.....	4.3%
Black.....	16.8%.....	17.8%
Hispanic/Latino.....	20.1%.....	20.9%
White.....	56.2%.....	54.1%
Two or More Races/Ethnicities.....	0.6%.....	0.7%

STEM ACROSS THE CAREER CLUSTERS[®]

Most of the 16 Career Clusters and related 79 Career Pathways are aligned explicitly to the STEM disciplines and specific STEM careers. For example, within the Agriculture, Food & Natural Resources Career Cluster, students can gain the foundational knowledge and skills to pursue careers in horticulture, animal science, environment science, mechanical engineering or food science, among other areas. Or within the Arts, A/V Technology, & Telecommunications Career Cluster, students can become prepared for careers in graphic or web design, video production, fiber optics and other diverse industries.

Even those Career Clusters individuals might not immediately associate with STEM can help prepare students for careers in the STEM field. For example, students in the Business Management & Administration Career Cluster will gain skills – such as strategies for analyzing information, understanding the life cycle of a research and development (R&D) process, organizational management skills, and so on – that could transfer to running a STEM-focused business. Or, students can learn about science and technology policy, intellectual property and patents, public health issues, and how to conduct statistical analyses to evaluate a policy or program through the Government & Public Administration Career Cluster. All of these skills have grounding in the basic STEM competencies, and have a direct application of knowledge of science, technology, engineering and/or mathematics.

Table 2 provides specific examples of the types of STEM-focused or STEM-related careers students can prepare for by participating in CTE programs aligned to The National Career Clusters Framework. These are just a sampling; there are many more careers – with different levels of education and training required – that could be included in the table. Importantly, every position listed requires some education and training beyond high school, often an associate’s degree or above.

Table 2: The Career Clusters and Sample Related STEM Careers

<i>Career Cluster</i>	<i>Samples of Stem Careers²⁵</i>	<i>Career Cluster</i>	<i>Samples of Stem Careers²⁵</i>
Agriculture, Food & Natural Resources	<ul style="list-style-type: none"> • Agriculture Technicians • Agriculture Engineers • Forest and Conservation Workers • Foresters • Food Science Technicians • Veterinarians • Marine Biologists • Water Resource Specialists v 	Hospitality & Tourism	<ul style="list-style-type: none"> • Museums/Zoos/Aquariums Personnel • Parks and Gardens Rangers • Brewers • Pastry and Specialty Chefs
Architecture & Construction	<ul style="list-style-type: none"> • Architects • Civil Engineers • Civil Engineering Technicians • Surveyors • Drafters • Cost Estimators 	Human Services	<ul style="list-style-type: none"> • Developmental Psychologists • Personal Trainers • Mental Health Counselors • Massage Therapists
Arts, A/V Technology & Communications	<ul style="list-style-type: none"> • Graphic Designers • Telecommunications Engineering Specialists • Multimedia Artists & Animators • Audio Technicians 	Information Technology	<ul style="list-style-type: none"> • Programmers • Hardware, Software Engineers • Computer Support Specialists • Information Security Analysts • Database Administrators • Webmasters • Video Game Designers
Business Management & Administration	<ul style="list-style-type: none"> • Accountants • Auditors • Operations Research Analysts 	Law, Public Safety, Corrections & Security	<ul style="list-style-type: none"> • Emergency Medical Technicians • Firefighter/Inspectors • Fire-Prevention and Protection Engineers • Brownfield Redevelopment Specialists and Site Managers
Education & Training	<ul style="list-style-type: none"> • STEM K-12 or postsecondary Teachers • Speech-Language Pathologists • Actuaries • Financial Analysts • Financial Planners • Loan Officers • Investment Bankers 	Manufacturing	<ul style="list-style-type: none"> • Aircraft Mechanics and Service/Avionics Technicians • Automotive Mechanics • Mechanical Engineers • Electronics Engineers • Electronics Engineering Technicians • Wind Turbine Service Technicians • Welders
Finance		Marketing	<ul style="list-style-type: none"> • Interactive Media Specialists • Market Researchers • Forecasting Managers • Inventory Manager/Analysts
Government & Public Administration	<ul style="list-style-type: none"> • Patent Officer • Cryptographers • Policy Analysts • Climate Change Analysts • Intelligence Analysts 	STEM	<ul style="list-style-type: none"> • Any/all of careers listed
Health Science	<ul style="list-style-type: none"> • Physicians • Nurses • Geneticists / Biotechnology Researchers • Biologists • Dietitians and Nutritionists • Dental Hygienists 	Transportation, Distribution & Logistics	<ul style="list-style-type: none"> • Transportation Planners • Transportation Engineers • Occupational Health and Safety Technicians • Transportation Vehicle, Equipment and Systems Inspectors



Green & Sustainability Standards

Another lens through which to examine how STEM exists across the 16 Career Clusters is to consider the effort led by states to develop Green & Sustainability Standards. The impetus behind this U.S. Department of Education-funded effort was the increase in “green” jobs, particularly at the high and middle skill levels, as well as a recognition that sustainability impacts nearly all industries and employees. This marked the first effort to map such expectations across a common set of CTE standards, the Career Cluster Knowledge & Skills Statements.

The result are four Green & Sustainability standards that apply across all 16 Career Clusters and Career Cluster-specific standards in six areas: Agriculture, Food, & Natural Resources; Architecture & Construction; Information Technology; Manufacturing; Science, Technology, Engineering & Mathematics; and Transportation, Distribution & Logistics. These six areas were identified as those being the most likely to experience the greatest need for green and sustainability workers.²⁶

THE STRATEGY

It should come as no great surprise that a number of states have made an explicit connection between their CTE and STEM policies and programs. Wyoming’s Education Coordinating Council hosted a STEM-CTE Summit in 2012 to plan their strategy comprehensively. Maryland’s Early College Innovation Fund was created to incentivize early college access programs for students pursuing CTE and/or STEM disciplines. Specifically, the Maryland State Department of Education generated competitive grants to fund partnerships of local school systems and higher education institutions to create early college high schools or other forms of early college access; priority is given to those programs that provide students with credentials (in the form of degrees, certificates and certifications, as appropriate) in fields for which there is high demand in Maryland.²⁷

North Carolina’s Board of Education-Approved STEM Strategy

Many states have STEM strategies and STEM networks charged with guiding those strategies. It is also quite common for state departments of education – along with state higher education commissions, workforce development agencies, and third-party business-led organizations – to support those networks as full partners. However, North Carolina has taken this one step further; the North Carolina STEM Network is leading a comprehensive STEM strategy that was developed jointly by the North Carolina Department of Public Instruction, the North Carolina Community College System, the North Carolina Science, Mathematics and Technology (SMT) Education Center, UNC General Administration, and Battelle Memorial Institute, and approved by the State Board of Education in 2011.

The NC STEM Network has three major goals:

1. Increasing STEM achievement (e.g., increase student interest and achievement in the STEM areas, and find a common way of measuring STEM attributes of schools, programs and students)
2. Increasing community understanding and support for knowledge-based economy (e.g., partnerships, awareness building)
3. Connecting STEM resources across public-private sectors (e.g., identify return on investment, and scale more effective programs efficiently)

What is striking about these three goals is how closely they resemble the principals for high-quality CTE identified in *Reflect, Transform and Lead: A New Vision for Career Technical Education*, demonstrating the natural connection between STEM and CTE.

To achieve the first goal, the North Carolina Department of Public Instruction and the NC STEM Network created 11 Attributes to assess a quality STEM program in K-12, offered in or out of school. According to the NC STEM Network, this rubric has direct application for analyzing programs more traditionally labeled as “CTE,” as it embraces the elements of high-quality CTE and is, again, well-aligned with the principles identified in the CTE Vision paper. This rubric is a strong tool in any CTE leader’s toolbox as they think about program quality and effectiveness.

North Carolina STEM School/Program

STEM Attributes * Reference STEM Implementation Rubric	Early →	Developing →	Prepared ●	Model ●
Integrated Science, Technology, Engineering and Mathematics (STEM) curriculum, aligned with state, national, international and industry standards				
1) Project-based learning with integrated content across STEM subjects				
2) Connections to effective in and out-of-school STEM programs				
3) Integration of technology and virtual learning				
4) Authentic assessment and exhibition of STEM skills				
5) Professional development on integrated STEM curriculum, community/industry partnerships and postsecondary education connections				
6) Outreach, support and focus on underserved, especially females, minorities, and economically disadvantaged				
On-going community and industry engagement				
7) A communicated STEM plan is adopted across education, communities and businesses				
8) STEM work-based learning experiences, to increase interest and abilities in fields requiring STEM skills, for each student and teacher				
9) Business and community partnerships for mentorship, internship and other STEM opportunities that extend the classroom walls				
Connections with postsecondary education				
10) Alignment of student’s career pathway with post-secondary STEM program(s)				
11) Credit completion at community colleges, colleges and/or universities **				

* Prepared or Model measure required for North Carolina STEM High School/ Program
 ** Not required for Elementary or Middle Schools

Another major element of North Carolina’s STEM strategy is to support the development of curriculum in key STEM areas where CTE is not currently filling the need in the state, namely biotechnology and agriscience, energy and sustainability, aerospace security and advanced manufacturing, and health and life sciences. With support from Race to the Top funds, the state is developing four-course sequences in these four content areas. While the courses are being designed as stand-alone sequences, they are intended to be taught either by CTE educators (as part of a CTE program of study) or by science and mathematics teachers. The curricula will be made available through Homebase, North Carolina’s statewide instructional improvement and student information system, allowing any teacher access to the curricula either as a full course or as an instructional resource to help them teach specific course objectives.

According to the former STEM leader within the NC Department of Public Instruction, Rebecca Payne, who also previously served as the State CTE Director, “for STEM to be successful, leadership will need to be taken by CTE. This is a chance for CTE to provide leadership within a school and to help teachers see the application of what they are teaching.”

Michigan STEM Partnership & CTE: Learning that Works for Michigan

The Michigan STEM Partnership²⁸ is a statewide, coordinated effort to promote STEM education and industry. Partners include the Michigan Department of Education, the U.S. Army, the Presidents Council for State Universities of Michigan, the Michigan Mathematics and Science Centers Network, Michigan Project Lead the Way, and other business, K-12 and postsecondary representatives.

The MI STEM Partnership's strategy is well-aligned and is inherently supportive of CTE programs and initiatives. Specifically, the Partnership identifies the following strategies:

1. Increase interest/awareness of STEM career opportunities among students, educators, parents, counselors and legislators.
2. Increase engagement and commitment of business and industry in the Partnership.
3. Increase the number of students who graduate from high school, career- or college-ready, without requiring remediation in STEM fields.
4. Increase the number of high school and college graduates in STEM fields.
5. Research and seek local, state and national funding opportunities in order to support the goals of the Partnership. Work statewide and/or with hubs as appropriate to respond to these opportunities.

Patricia Cantu, Michigan's State CTE Director at the Michigan Department of Education, serves as a board member for the STEM Partnership, a working board that meets monthly. Additionally, the CTE: Learning that Works for Michigan logo, which is used by the Michigan Department of Education's Office of Career and Technical Education is also included in the Partners, demonstrating that CTE is not only involved, but has been embraced as part of the STEM strategy.²⁹

Ohio's Hybrid Academic and CTE Curricula

As part of Ohio's Race to the Top award, the state released a Request for Proposal in 2011 entitled "Establishing Career-Technical Education within Ohio's STEM Network through Hybrid Academic and Technical Workforce Curricula." The grant is now being managed by the Ohio Association of Career-Technical Superintendents (OACTS) to facilitate the development of what Tom Applegate, the Executive Director of OACTS, called a "STEM-CTE hybrid curriculum in health informatics."

Ohio chose to develop a four-course program of study in health informatics, as it is a high-demand field that exemplifies the various disciplines within STEM. With an emphasis on the analysis of "big data" at the population level, the analysis of individual health information data, and a patient care component, health informatics draws on statistics, mathematical modeling, computer science and health science. The Ohio Department of Education has developed a template to allow courses, such as these four, to count for simultaneous CTE and academic credit. The initial goal is for each of the four courses to count for up to a quarter credit of statistics, aligned to the Common Core State Standards, with other opportunities for academic and CTE credit to be identified along the way.

Ohio's project is part of the Southern Regional Education Board's (SREB) Advanced Career initiative, and the final curricula will be made available free for all of Ohio's schools. The courses, each of which is comprised of six projects, are being piloted in both technical centers and comprehensive high schools at this time. For more information, see <http://ohioacts.org/informatics.html>.

WHERE STEM CAN SUPPORT & ADVANCE CTE

Just as CTE can be an effective pathway for STEM education, efforts to bolster STEM education across the nation can advance certain CTE programs and goals. Efforts to support STEM and CTE are mutually reinforcing, and there are also advances driven by the STEM reform movement that can help advance CTE, such as:

Elementary & Middle School Exposure:

Students rarely have access to CTE before high school; at most, they have access to career exploration opportunities in middle school. Many STEM programs, though, focus on engaging students in the earliest grades. These programs should be connected explicitly to the CTE programs available to those elementary students once they hit secondary school to encourage both higher engagement in the traditional science and mathematics courses as well as higher enrollment in the technical courses.

Out-of-School Partnerships:

There is increasing interest in expanding work-based learning opportunities, including, but not limited to internships,³⁰ but they can be challenging to coordinate, maintain and bring to scale. However, many companies and business organizations have demonstrated a public commitment to increasing our STEM pipeline. Part of this may simply be a communications and marketing tactic, but building the linkages between CTE and STEM to business leaders and employers can impact the availability of work-based learning opportunities for a broader array of students.

Groups like Change the Equation³¹ and STEM Connector³² are engaging a broad base of companies and business leaders around STEM education. In the case of Change the Equation, they are focusing particularly on improving access for girls and students of color who traditionally have been underrepresented in STEM fields. These organizations can serve as both a model for business engagement and also a vehicle for building the bridge between STEM and CTE among the nation's CEOs and business executives.

Integrated Teaching and Credits

Finally, a number of states are moving towards integrated teaching or awarding credits to students based on the demonstration of competency in a content area rather than seat time. This not only allows for differentiated instruction based on students' learning styles, but it also encourages more cross-disciplinary teaching and learning.

Related, some states and institutions of higher education have begun offering pre-service and in-service teacher certifications in STEM. These certifications are an effective strategy for getting more CTE teachers certified to teach academic courses and vice versa, as many programs focus on engineering and design principles, which have applications across technical and academic areas. With policies structured strategically, more teachers will be certified and qualified to teach courses that potentially award both CTE and science or mathematics credit (e.g., a biotechnology class that counts towards a biology credit and a CTE credit in health sciences).

QUESTIONS FOR CONSIDERATION

As states and communities consider their STEM initiatives currently underway or in the process of being scaled up, there are some important questions they may ask to ensure they are fully leveraging their CTE efforts and focusing on filling gaps rather than recreating the wheel:

- In what industries are CTE programs of study well-aligned with your state's or region's labor market needs (or, where does your state already have strong education-to-workforce pathways)?
- Based on labor market data, where are there gaps in your state's CTE programs of study (or, where do you need more or stronger education-to-workforce pathways)?
- How can the interdisciplinary professional development occurring under the auspices of STEM education be extended to more (or all) CTE and core academic educators?
- How can STEM-based career guidance be expanded into broader career guidance, which is otherwise under-provided, especially in the earlier grades?
- How can the instructional and/or programmatic tools and resources being created through your state's STEM initiative be integrated or leveraged by CTE educators (and vice versa)?
- What strategies are in place to ensure no barrier is being set up – real or perceived – between “STEM” educators and “CTE” educators?

CONCLUSION

This paper aims to make the case that CTE and STEM need to be better connected at the policy, practice and rhetorical levels, given their shared goals, elements and stakeholders. While the paper contends that CTE needs to be a major element of any state's or community's STEM strategy, it is fair to say that STEM is CTE, given its focus on integrated learning, the application of knowledge and skills, and career preparation. Looking ahead, state and local leaders should work collaboratively to identify where CTE is delivering high-quality STEM skills and competencies successfully, where efforts need to be shored up, and how to best scale those programs with the greatest value to students, employers and our nation.

FOOTNOTES

- 1 2008 Route to the Top, http://content.spencerstuart.com/sswebsite/pdf/lib/2008_RTTF_Final_summary.pdf
- 2 To see sample plans of study for STEM programs of study, see <http://www.careertech.org/career-clusters/resources/plans/science.html>
- 3 Change the Equation. Vital Signs: *STEM Help Wanted*. http://changetheequation.org/sites/default/files/CTEq_VitalSigns_Supply%20%28%29.pdf
- 4 Carnevale, A. et al (Oct. 2011). *STEM*. Center for Education and the Workforce, Georgetown University. <http://cew.georgetown.edu/stem/>
- 5 Rothwell, Jonathan (June 2012). *The Hidden STEM Economy*. The Brookings Institute Metropolitan Policy Program. <http://www.brookings.edu/research/reports/2013/06/10-stem-economy-rothwell>
- 6 Next Generation Science Standards, Appendix I: Engineering Design in the NGSS. http://nextgenscience.org/sites/ngss/files/Appendix%20I%20-%20Engineering%20Design%20in%20NGSS%20-%20FINAL_V2.pdf
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