STRATEGIES FOR LEVERAGING STEM IN SUPPORT OF COLLEGE- AND CAREER-READY GRADUATION REQUIREMENTS

Science, Technology, Engineering and Mathematics (STEM) education opportunities have gained significant attention over the past few years—with increased investments and expanded programming. Policy leaders recognize that STEM, now more than ever, is fundamental to ensuring the supply of talent necessary for a competitive U.S. workforce. Indeed, STEM programs and partnerships increasingly are being used in economic development strategies, particularly as states and regions recruit new companies and industries that require a well-educated and STEM-literate workforce.

Policy and education leaders are also increasingly identifying STEM as one of the most effective vehicles for preparing students for success in college and careers in a number of ways. For one, there are a number of well-regarded career and technical education (CTE) programs that are STEM-focused and provide a technical or applied context for academic learning. These STEM programs may also incentivize students to complete a full college- and career-ready curriculum to complement the rigorous CTE pathway. STEM also may provide opportunities for states to develop new, integrated courses (such as an engineering, biotechnology or computer science course), that give students more options for how they can meet their college- and career-ready math and science requirements. Finally, beyond the courses themselves, the best STEM programs typically leverage and utilize hands-on and experiential learning – through partnerships, the use of technology, the art of design, etc. – that can be replicated in other non-STEM courses to improve teaching, learning and student engagement across the board.

A key lesson from Achieve's *Taking Root* research on sustaining state education policy change is the importance of connecting and integrating reform policies – so that the whole is stronger than the individual parts. There are many ways in which STEM and the rigorous graduation requirements reinforce one another, in particular around their shared focus on readiness for college and careers, and how they both thrive with engagement from the local business and higher education communities.

A Closer Look at STEM: Distinguishing Characteristics

STEM, in its assorted forms, consists of the best of more than ten years of education reform efforts: aligned standards, multivariate-assessments, accountability measures, early college opportunities, lab-based/project-based instruction, tech-prep/career technical education, cutting edge teacher professional development and, of course, rigorous high school graduation requirements.

In general, high-quality STEM programs reflect the following distinguishing characteristics, all of which enhance the college- and career-ready agenda both from an implementation and communications stand point:

Opportunity for all… Contrary to popular belief, STEM is neither elitist nor selective. Most programs have no criteria for admission and strive to increase access and reach a variety of diverse student populations—often with a special emphasis on disadvantaged students. Disadvantaged students traditionally have less access to advanced math and science courses, even though their interest in those courses is on par with the interest of their more advantaged peers. The growth of STEM learning can go a long way towards providing new opportunities for students previously denied advanced course-taking options. According to a 2007 report on Project

What is STEM?

At the most basic level, "STEM" simply encompasses any coursework in science, technology, engineering and mathematics. But STEM, taken more broadly, is one of the most powerful strategies for states working to offer multiple – but equally rigorous – pathways or opportunities for learning. Most notably, it can change the game of "how" students earn required credits for high school graduation. Several states have embraced STEM as a critical component of their high school reforms efforts —in conjunction with other strategies—through the creation of STEM schools, pathways, curricular models and professional development opportunities that transform teaching and learning and propel *all* students to postsecondary success.

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Lead the Way, participation of minority and low-income students in the rigorous pre-engineering program was proportional to each state's demographic make-up.

Cross-disciplinary approach... Unlike the traditional high school model, which is often characterized by a "four-by-four" course-taking schedule, STEM is often characterized by a cross-disciplinary approach to teaching and learning. Rather than completing four years of four (or five) subjects taught in separate spaces, students often engage in project-based learning that infuses the disciplines, including the arts, and promotes relevance and a real-world approach. When STEM programs succeed in their inter-disciplinary approach, they reinforce critical academic and technical knowledge and skills by demonstrating how various disciplines and bodies of knowledge interact and reinforce one another.

Real-world application... Many STEM programs aim to transform teaching and learning through innovative professional development opportunities and the use of models that expose students to the real world through in-school opportunities (such as career technical education, project-based learning, lab experiences) and out-of-school opportunities (such as co-ops, internships, tech prep, dual enrollment). These are all elements that can also be used to bolster states' academic graduation requirements as well, by providing opportunities outside the traditional classroom to demonstrate the contextual importance of academic knowledge and skills.

Diverse partners... Strong STEM programs are rooted in a broad base of vested partners from across Pre-K-12, higher education, business, community and foundations. These partners help enhance the teaching and learning process, ensuring that STEM education goes beyond the four walls of the schoolhouse. Given the vested interest in successful STEM programs and learning from state and local business, labor and economic development communities, STEM provides an opportunity to engage additional leaders around the broader college- and career-ready agenda, and to leverage their expertise to inform curriculum, projects and out-of-school learning opportunities. STEM is also a vehicle through which to engage the higher education community in partnering with K-12 schools around the goal of strengthening the pipeline of well-prepared students entering STEM disciplines. STEM provides opportunities for K-12 and higher education to come together to align expectations, develop or validate curriculum, and create programs to ease the transition from high school into two- and four-year colleges.

Implementing STEM and College- and Career-Ready Graduation Requirements

Many STEM models or strategies underway are in the formative stages of development and may be best positioned to thrive over the long term if they are used as a vehicle for promoting the broader college- and career-ready agenda. Of course, college- and career-ready graduation requirements can also provide new opportunities for STEM programming and learning. There are a number of steps states can take to ensure STEM and college- and career-ready graduation requirements work together and are connected including:

- Consider STEM education through a Pre-K-20 education lens and modify funding formulas to honor this holistic approach.
- Develop shared goals for high school and postsecondary completion and entry into the workforce for all students and the STEM disciplines, specifically.
- Ensure any new STEM courses or pathways are well-aligned with academic standards – and provide opportunities for students to apply contextualized knowledge in real-world settings. The adoption and implementation of the Common Core State Standards provides a timely opportunity for states to take a fresh look at their STEM programming and the academic content embedded within them.

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- Embrace the project-based learning that is often central to STEM learning and apply that type of teaching, learning and assessment in core academic courses as well.
- Foster local innovation around the development of new STEM courses and pathways, create a state mechanism for reviewing and validating any locally-developed curriculum, and develop the partnerships and processes necessary for the postsecondary community to verify those courses as meeting admissions or dual enrollment requirements.
- Allow validated STEM courses to count towards high school graduation – and postsecondary admissions – requirements, either as a core course or an academic elective.
- Partner with the local, regional or state business and postsecondary communities around the development of STEM programs of study and curriculum, including the design of project-based learning based on real-world problem solving and the creation of aligned out-of-school opportunities.
- Partner with the local, regional or state business and postsecondary communities around the development of professional development standards and experiences, such as on-site externships, for teachers of the STEM disciplines.
- Leverage the growth in (and popularity of) STEM programs to address college- and career-ready access issues present in rural schools through innovation in virtual learning and other regional strategies.
- Push STEM learning down into the earlier grades to increase interest among students, educate them about their course-taking options, and ensure they are taking the courses and mastering the content necessary for success in high school-level STEM and other college- and career-ready coursework.
- Identify and communicate the existing and projected STEM jobs in the state (ranging from PhD-level to those requiring an associate's or another technical degree) to demonstrate why all students should complete a rigorous curriculum in high school. It's important to stress that STEM jobs aren't just for those with advanced degrees; there are many technician-level jobs that are in-demand and STEM-focused.

Promising State Models
While the states below have programs that are still in varying stages of development, each shows promise of large-scale impact and longer-term sustainability, utilizing partnerships and regional approaches. Notably, all three of the states highlighted have adopted college- and career-ready graduation requirements.

- ***Ohio*****—**Guided by a 2007 state statute that codifies a public-private partnership between the State of Ohio and Battelle Memorial Institute, Ohio has stressed a network approach to STEM education. The Ohio STEM Learning Network (OSLN) connects the work of STEM regional hubs, which cradle STEM schools and programs. They are supported by partners from K-12 education, higher education, business and philanthropy across the state. The OSLN currently connects five hubs, 10 STEM schools, 26 Programs of Excellence, more than 40 higher education partners, 80 plus public school district partners, more than 300 community and business partners, and leverages more than $109.4 million in public and private resources. For more information, visit: www.OSLN.org.

- ***Texas*****—**Perhaps the first state to adopt STEM education programming, through its Texas High School Project, the Texas Education Agency funds STEM initiatives that impact more than 80,000 students, 47 STEM schools and 7 T-STEM Centers that develop and share best practices and innovation. Texas has achieved a viral effect in the creation of STEM schools, as several traditional school districts are now

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establishing STEM schools on their own, with no additional assistance from the state. Texas combines STEM programming with Early College and career and technical education. This approach enables students to earn up to 12 college credits prior to high school graduation. To learn more, please visit: http://www.tstem.org/.

- ***Tennessee***—A budding initiative developed in late 2009, Tennessee plans to partner with Battelle Memorial Institute and Oak Ridge Associated Universities to knit together the state's STEM assets. In concert, partners will develop a state STEM strategic plan that will identify current pockets of success and existing gaps. The plan will be used to power the "state's new economy." Tennessee's efforts, already receiving strong state financial support, received an additional $29 million boost thanks to the state's successful Race to the Top proposal. The state's initial focus will target teachers, schools and communities. It will develop six STEM hubs and six platform STEM schools to engage public schools and partners across the state.

Potential Challenges

While STEM (through schools, programs, curricular models and professional development) stands as a strategy for successful implementation of rigorous high school course requirements, there are potential challenges to consider when moving forward:

- ***Long-term funding***. Many states have front-loaded funding to help STEM schools and programs get off the ground. Vested partners from education, business and philanthropy can help close operational funding gaps, but long-term challenges can persist if states do not modify broader funding formulas to recognize the unique nature of the STEM learning model, which, much like career and technical education strategies, often requires more resources than the traditional classroom.

- ***Scalability***. STEM is often best served in small learning environments, where lab-based and project-based instruction can thrive. Consequently, it is challenging to scale efforts. As a remedy, many states are pursuing their STEM efforts through a network approach that fosters connections and promotes sharing of best practices, particularly with regard to STEM schools. In Ohio, for instance, STEM programs are connected through the Ohio STEM Learning Network. The network's mantra: *small schools, big footprint*. Additionally, one of the most transportable functions of STEM learning is educator professional development. Several states have paid special attention to using professional development programs to spread impact and act as an agent of change outside of or within the traditional education system.

- ***Program fidelity.*** As a result of long-term funding and scalability challenges, the fidelity of STEM programs might be jeopardized as states seek to implement programs with little recognition of the resources and policy pieces required for successful implementation. This compromised fidelity can result in decreased performance and minimize the impact of STEM programs.

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