

National Association of State Boards of Education

## ⊕ Improving STEM Learning through Collaboration

By Joseph Hedger

**F**or many U.S. students, access to instruction in science, technology, engineering, and mathematics (STEM) is not a given. According to the Civil Rights Data Collection, high schools with high black and Latinx student enrollment offered math and science courses at a lower rate than the overall population in 2015–16, most evident in advanced mathematics and physics. Rural students also tend to get less access to STEM courses, and they make up about one-fifth of all students.<sup>1</sup>

Yet STEM jobs represented 6.2 percent of U.S. employment in 2015. In addition, the sector shows above average growth, and wages are above the national average in 93 percent of STEM occupations.<sup>2</sup>

Access is a necessary but not sufficient condition for a quality STEM education. North Carolina, Massachusetts, Iowa, and the District of Columbia all involved community leaders in decisions about what STEM skills students need to learn. State leaders are revising learning standards, creating school-to-college programs, and brainstorming ways to staff hard-to-reach areas with STEM-prepared teachers. They also are partnering with businesses, higher education, and other stakeholders to produce the best results.

### STAKEHOLDER ROLE IN STANDARD SETTING

The **District of Columbia State Board of Education** adopted the Next Generation Science Standards (NGSS) in 2013, cognizant that some DC students were not receiving any science instruction. The standards are

intended to give local educators flexibility in designing learning experiences that stimulate students' interest and prepare them for college and careers.

"NGSS represented a huge opportunity to advance equity but also advance educational opportunities," said Mary Lord, an editor at the American Society of Engineering Education and then member of the DC State Board of Education. Policymaking is where opportunity meets advocacy, she added. Before adoption, the board advocated for new standards in public engagement sessions, which included short demonstrations such as an engineering design challenge to see who could make a straw fly farthest by attaching two paper hoops to it.

Science teachers volunteered at these meetings to demonstrate their own engineering design problems. Some of the strongest teacher advocates for new standards taught at the worst-performing high schools, Lord said.

Discussion of learning standards should not take place behind closed doors, she added. Businesses, colleges, and community stakeholders should weigh in on what graduating kids need to know. Lord said the state board's role is to seek information: "What do we mean by science, technology, engineering, or mathematics? What are we talking about when we talk about STEM?" Work with science teachers and employers to formulate responses, urged Lord. "Enlist your chamber of commerce; that's who legislatures listen to."

For DC, rolling out the standards without an aligned assessment was the biggest hurdle

to determining how well the new standards were being implemented, especially since project-based learning is such an important component of the standards. This gap reinforces what Lord called the tyranny of reading and math scores, because there is no counterbalancing assessment of other subjects. State board members should look for other ways to validate learning that leave room for project-based and STEM education, she said.

In its 2016 revised science standards, **Massachusetts** sought to further integrate science, technology, and engineering (STE) instruction. A collaboration of education stakeholders from higher education, an advisory council, the Massachusetts Department of Elementary and Secondary Education, and others helped adapt these standards from the NGSS so educators and districts could benefit from commonality across the states. The 2016 revisions include grade-by-grade elementary school standards that include all STE disciplines. The inclusion is important because early childhood, a critical time for effective STEM learning, is typically given low priority in STEM education discussions, according to a Science Leadership Initiative report.<sup>3</sup>

According to the STE curriculum framework, the statewide guidelines from which the revised standards were established, an integrated model for the Massachusetts preK-8 STE standards reflects the following: "that science is complex and multidisciplinary; research on learning in science that shows expert knowledge develops through interdisciplinary connections, not isolated concepts or practices; [and] effective research-based practices for curriculum and instruction in science and engineering."<sup>4</sup>

Celestin Ntemngwa and J. Steve Oliver define integrated STEM instruction as a “pedagogical approach in which concepts and objectives from two or more STEM disciplines are incorporated into a single project.”<sup>5</sup> Students can thus learn to apply synthesized concepts to real-life problems, which can be an uncommon skill to acquire in single-subject classrooms. For example, teachers use Lego Mindstorms software in middle school science classrooms to intertwine key concepts in computer programming and robotics.

**North Carolina** also began their STEM initiatives by asking what higher education and the business sector needed from their future students and workforce. With a critical focus on economic development, education leaders developed a North Carolina STEM strategic plan, which laid out three priorities for the state’s education sector: improving STEM achievement; bolstering community understanding and support; and connecting, leveraging, and increasing STEM resources. This plan set a foundation for students to be able to enter the STEM workforce, which expects a greater growth rate than the average North Carolina job and 64 percent higher pay.<sup>6</sup>

**Iowa** launched a STEM advisory council in July 2011 to lay out a strategic plan for educational and economic opportunities in STEM. The STEM Advisory Council has three integral levels of advisory boards: a 15-member executive committee; a statewide, 50-member advisory council; and regional advisory boards in each of the six regions, each of which has a regional manager to facilitate programs and promote further engagement.

Through the council’s STEM BEST® (Businesses Engaging Students and Teachers) program, awards are made with a 1:1 business match grant of up to \$25,000 for model programs to initiate school and business partnerships in STEM. These include student internships, project-based learning collaborations, and professional development for teachers—a collaboration that council staff value greatly. “It all has to work together,” said Carrie Ranking, managing director of the STEM Council. “It’s a pipeline.”

Council partnerships also support teacher externships—where teachers work side by side with industry employees during the summer so they can help students learn what kind of work STEM companies do—as well as career pathways that exist in their own backyard.

These STEM initiatives have faced no significant hurdles. “We have really enjoyed an aligning of the stars,” said the council’s interim executive director, Cindy Dietz. “Legislators, businesses, and educators found this is to everyone’s benefit.” The council wants to reach all parts of Iowa, including rural areas that lack the resources or capacities of other schools.

### **COLLABORATING ON CURRICULUM AND MATERIALS**

One example of collaboration is the UTeach network, started by STEM faculty and teaching practitioners at the University of Texas at Austin in order to involve higher education in recruiting and developing STEM teachers. Now extending across 45 universities in 22 states and DC, UTeach provides a network of support, professional development, and partner programs to prepare teachers for long-term careers as STEM teachers.

The Wake STEM Early College High School is a North Carolina magnet school, developed in partnership between the Wake County Public School System and North Carolina State University and approved by the North Carolina State Board of Education in 2011. It offers its students—half of which are required to be first-generation college goers—college-level courses and hands-on STEM education. Students wishing to major in a STEM concentration can earn up to two years of college credit at North Carolina State over the course of Wake STEM’s five-year curriculum.

### **STEM DIPLOMAS**

Seven states have created a STEM diploma or distinction, where students can earn graduation endorsements or distinctions based on STEM academic success and/or project completion.<sup>7</sup> Colorado House Bill 17-1201, which established the Centennial State’s high school diploma endorsement in STEM, requires local school districts to work with

STEM employers and higher education institutions to develop curriculum and guidelines to enable students to graduate at a high level of proficiency, complete a coherent sequence of at least four STEM courses, achieve a minimum score on one of several specified mathematics assessments, and complete a final capstone project that demonstrates subject mastery.<sup>8</sup>

Whether through revised standards, special diplomas, or promoting partnerships to provide quality instruction, state boards of education have a role in enhancing STEM learning. Such learning ought to be hand in glove with a host of other skills in communications, philosophy, and ethics, DC’s Lord suggests. “STEM is an essential component to balanced education to promote creators of the future,” she said.

*Joseph Hedger is NASBE’s associate editor.*

### **NOTES**

1 Civil Rights Data Collection, “2015–16 Civil Rights Data Collection: STEM Course Taking” (Washington, DC: U.S. Department of Education, 2018); Megan Lavalley, “Out of the Loop: Rural Schools Are Largely Left Out of Research and Policy Discussions, Exacerbating Poverty, Inequity, and Isolation” (Alexandria, VA: Center for Public Education, 2018).

2 Stella Fayer et al., “STEM Occupations: Past, Present, and Future” (Washington, DC: U.S. Bureau of Labor Statistics, 2017).

3 Ashley Chiu et al., “Supporting Elementary and Middle School STEM Education at the Whole-School Level: A Review of the Literature” (Chicago: Science Leadership Initiative, 2015), [https://www.msichicago.org/fileadmin/assets/educators/science\\_leadership\\_initiative/SLI\\_Lit\\_Review.pdf](https://www.msichicago.org/fileadmin/assets/educators/science_leadership_initiative/SLI_Lit_Review.pdf).

4 Massachusetts Department of Elementary and Secondary Education, “2016 Massachusetts Science and Technology/Engineering Curriculum Framework” (Malden, MA, 2016).

5 Celestin Ntemngwa and J. Steve Oliver, “The Implementation of Integrated Science Technology, Engineering and Mathematics (STEM) Instruction Using Robotics in the Middle School Science Classroom,” *International Journal of Education in Mathematics, Science and Technology* 6, no. 1 (2018).

6 Public Schools of North Carolina, “North Carolina’s Science, Technology, Engineering, and Mathematics Education Strategic Plan” (Raleigh, NC: North Carolina Department of Public Instruction).

7 Jennifer Zinth, “High School Diploma Options That Meet Federal Graduation Rate Calculation Requirements” (Denver, CO: Education Commission of the States, 2018).

8 Shannon Nicholas et al., “STEM Diploma Is a Signal of Students’ Readiness for Industry and Higher Education” (Denver: Colorado Succeeds, 2017).

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