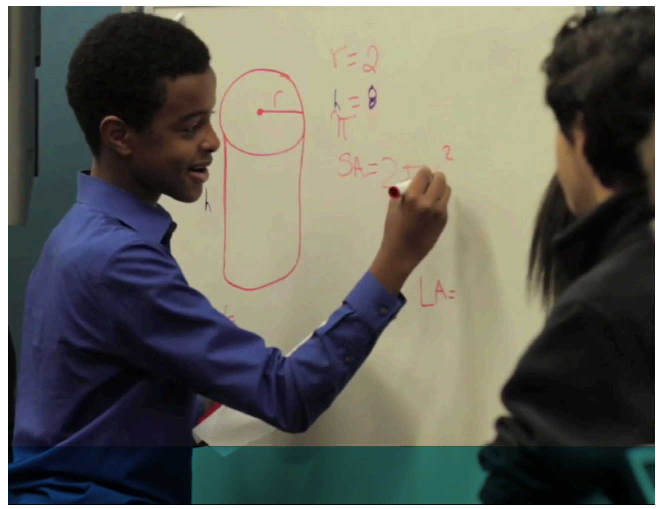
Bringing Inclusive STEM High Schools to Scale: Policy Lessons from Three States

*By: Viki Young, Sharon Lynch, Barbara Means, Ann House, Vanessa Peters, and Carrie Allen**

*All authors are from SRI Education, except Sharon Lynch, who is from George Washington University.

A highly qualified and ample STEM workforce is viewed as an economic imperative for the country, individual states, and different geographic regions. Yet equitable access to high-quality college preparation in STEM for students from underserved and underrepresented groups is an enduring policy challenge. Several states have responded to both these challenges with statewide initiatives to create inclusive STEM high schools (ISHSs) that are connected through state-run or public-private collaborative networks. The ISHSs' mission is to recruit and prepare students who are interested in STEM and who are from diverse backgrounds rather than targeting only those who have demonstrated math and science talent before high school. School districts, too, have invested in inclusive STEM schools, often under a portfolio approach that meets differing family needs and aligns with local industry, economic development goals, and opportunities for high-quality jobs and careers.



The iSTEM Study

iSTEM is a longitudinal study of the scale-up and impacts of inclusive STEM high schools in three states that have developed facilitative educational policies and invested significantly in ISHSs—North Carolina, Ohio, and Texas. This study is following cohorts of 9th-graders through their 12th-grade year and cohorts of 12th-graders through 2 years after high school graduation. By examining the STEM education and out-of-school opportunities of students in ISHSs and traditional comprehensive high schools, the objective is to uncover relationships between students' high school experiences and their secondary and postsecondary outcomes. Using a quasi-experimental design to match ISHSs with comparison high schools serving similar students in the same state, we are estimating the impact of attending an ISHS on high school achievement in math and science, students' STEM identity, postsecondary STEM course-taking and grades, and interest in STEM careers. We have interviewed key state policymakers about their respective state ISHS initiatives, exploring how they created a successful framework for ISHS-related legislation and policies, as well as the results and any unintended consequences. We also have interviewed district and school leaders about the influences of relevant state education policies on their local ISHS implementation efforts.

Our research evidence demonstrates that ISHSs provide curricular and instructional experiences that are STEM focused and more rigorous than those similar students in traditional schools receive. The effects of

ISHSs are particularly notable for students from groups underrepresented in STEM who otherwise would be less likely to have such STEM learning opportunities. In North Carolina,[1] for example, ISHS 12th-graders overall, African Americans, and females reported taking precalculus or calculus, physics, and chemistry and participating in STEM-related experiences in their communities at higher rates than peers at matched comparison schools. In Texas, ISHS students showed similar course-taking patterns. They also expressed a stronger sense of identity in math and science, a greater sense of math efficacy, and more persistence in overcoming difficulties in math and science than similar students attending high schools without a STEM focus.[2] These results suggest that ISHSs merit state policymakers' attention.

This policy brief provides lessons learned about ISHS scaling efforts—and the policies intended to support them—in North Carolina, Ohio, and Texas. The aim is to provide insights for state policymakers and education leaders eager to adopt similar measures to support or expand inclusive STEM high school education in their states. State policymakers play a critical role in enabling the creation and scale-up of ISHSs by setting the vision and expectations for the schools, supporting their development with technical assistance and resources, addressing inadvertent policy barriers for local schools and districts, and identifying and capitalizing on existing organizational networks and regulations that could enhance STEM education. We hope these insights support state policymakers in this crucial role.

Policy Lessons Learned to Support State ISHS Initiatives

I. Align key stakeholders

A statewide ISHS initiative requires broad-based stakeholder commitment including the K–12 state education system, higher education system, private partners such as industry and philanthropy, and state-level executive and legislative support.

II. Create a design blueprint for ISHSs

A design blueprint communicates expectations about the rigor and focus of STEM curricula, instructional approaches, and school partnerships with higher education and industry A common set of specific ISHS elements aims key players in the same direction and provides a framework for development, support, improvement, and progress measures for individual ISHSs and for the initiative as a whole.

III. Develop a system for monitoring and supporting new ISHSs

A structured process and criteria for ISHS designation, with feedback on each school's development, accountability for implementing the blueprint elements, and the potential for revoking the STEM designation enhances the quality of new ISHSs and helps them adhere to policymakers' intentions.

IV. Allocate resources and institutionalize funding

State policymakers can facilitate ISHS development by allocating resources to support local capacity building.

V. Create a STEM workforce development plan

A STEM workforce plan should include strategies for creating a vigorous STEM teaching corps.

VI. Create a high school-college dual credit system.

State policies authorizing and facilitating dual credit courses give ISHSs additional tools to boost curricular rigor and prepare students from underrepresented groups for postsecondary education.

1 B. Means, H. Wang, X. Wei, S. Lynch, V. Peters, V. Young, & C. Allen (2017), Expanding STEM opportunities through inclusive STEM-focused high schools, *Science Education*, DOI 10.1002/sce21281.

2 To see an example of an ISHS in action, view this brief video of Metro Early College High School in Columbus, Ohio, which combines the early college high school model with an inclusive STEM focus. https://ospri.research.gwu.edu/day-life-videos

Lessons Learned

I. Align key stakeholders. A statewide ISHS initiative requires broad-based commitment from stakeholders, including the K–12 state education system, higher education system, private partners such as industry and philanthropy, and executive and legislative branches of state government.

In each state in the iSTEM study, strong—often bipartisan—leaders from the governor's office and state legislature worked together with the private sector, higher education institutions, and state departments of education to develop strategies for creating and scaling up ISHSs (Figure 1). Representatives from these sectors networked at the state and regional levels to leverage their influence and align elements of the education system that do not typically work together. They played complementary roles that no single entity could have accomplished independently. The legislature and the governor's office set the political agenda and rationale for an ISHS initiative, sometimes in response to economic needs and goals. They also enacted facilitating legislation such as STEM credit requirements, start-up funding, and dual credit structures bridging K–12 and higher education systems.

Staff in state education agencies had the responsibility for interpreting enabling legislation through such means as creating "blueprint" descriptions to guide local educators in establishing ISHSs, forming a technical assistance infrastructure, and implementing feasible, efficient, and effective structures for approving, starting up, monitoring, and supporting ISHSs.

Figure 1. Aligned Key State-Level Stakeholders for ISHS Initiative

Private foundations in these states were integral in building alliances and providing financial incentives and technical supports for STEM high schools. They increased the capacity of the state education agency in critical ways to carry out the ISHS initiative. For example, the foundations provided seed funding for coaching ISHS school leaders and convened industry partners to garner their support and assess local needs. They also advocated for crucial policy changes with state legislators, something that state education agency staff could not do. Over time, as funding and economic priorities shifted, private partners argued for connecting career/technical education funding with existing STEM school initiatives.

II. Create a design blueprint for ISHSs. A design blueprint communicates expectations about the rigor and focus of STEM curricula, instructional approaches, and school partnerships with higher education and industry. A common set of specific ISHS elements aims key players in the same direction and provides a framework for development, support, improvement, and progress measures for individual ISHSs and for the initiative as a whole.

Because ISHSs were a new kind of high school, each state established a blueprint or set of guidelines that convey the important design elements of an ISHS, including STEM course requirements, instructional strategies such as project- or problem-based learning, college-level coursework, and work-based learning opportunities. The blueprints also specify ways that industry, nongovernmental organizations, and higher education institutions could partner with ISHSs.

The states' STEM blueprints help define the curricular rigor necessary for students to be well prepared for STEM college majors and careers, setting a higher bar than the statewide standards for earning a high school diploma. Completing a STEM college major within 4 years generally requires that a student be ready for calculus in the first year of college, so states could require that ISHSs include precalculus as a graduation requirement. Increasingly, students in ISHSs must also take introductory engineering or other career/technical education (CTE) courses. Blueprints for ISHSs may also specify STEM capstone projects or internships that connect the school with the local STEM professional community as graduation requirements.

To fulfill the goal of attracting students from underrepresented groups, the state-level blueprints also articulate guidelines for recruitment and open access, such as by using lottery-based admission processes that follow the state's rules for open charters (while most of the ISHSs are schools of choice, many are not charter schools). The blueprints can also require ISHSs to maintain a minimum percentage of students from underrepresented groups. The blueprints for the three states differ in their detail, as illustrated by the sample excerpt on curriculum and project- or problem-based learning.

The most detailed blueprint, from Texas, takes a developmental approach at the school level by articulating appropriate activities during the planning year, the first year of implementation, the second year, and then beyond. The Texas blueprint lays out more fundamental structures needed in the opening years such as a qualified teaching staff and STEM curricular plan. Resources supporting students in upper grades, such as work internships and dual credit opportunities, are phased in by the second year of operation.

Sample Excerpts from STEM Blueprints and Designation Guidelines

Varying Statements about STEM Curriculum and Project- or Problem-Based Learning

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…
4) Authentic assessment and exhibition of STEM skills….
8) STEM work-based learning experiences, to increase interest and abilities in fields requiring STEM skills, for each student and teacher.

—North Carolina STEM Attributes

Evidence that the school will offer a rigorous, diverse, integrated and project-based curriculum to students in any of grades K-12…and does all of the following:

a) Emphasizes the role of science, technology, engineering and mathematics in promoting innovation and economic progress;
b) Incorporates scientific inquiry and technological design;
c) Includes the arts and humanities;
d) Emphasizes personalized learning and teamwork skills

—Ohio STEM Designation criteria

5.1.D Supports and encourages all students to successfully complete four years of mathematics, four years of science, four years of STEM electives, and at least one Endorsement in STEM, Business and Industry, Public Services, or Arts and Humanities, with a primary focus on a STEM Endorsement; and earn a Distinguished Level of Achievement as well as a Performance Acknowledgement in order to graduate college ready.

5.1.E Offers dual credit, articulated concurrent enrollment, AP or IB courses so that all students will graduate with 12-30 college credit hours.

5.2.G Develops 6th–12th students' portfolios of interest in: STEM capstone projects, STEM internship opportunities, and global STEM college, degree, and career explorations. Requires all high school students to complete an internship, and/or a STEM-related capstone project, presentation, and defense; primarily focused in the state's STEM-related economic development clusters (information and computer technology, energy, petroleum refining and chemical products, advanced technologies and manufacturing, aerospace and defense, biotechnology and life sciences).

5.3.C Organizes instruction expectations around problem-based and project-based learning with clearly defined learning outcomes for students and teachers that address state and national performance standards, college and career readiness standards, and industry expectations.

—T-STEM Blueprint

Varying Statements about Recruitment of Students from Groups Underrepresented in STEM

The proposal [to be designated a STEM school] emphasizes student interest in STEM disciplines and careers, regardless of past performance, and participation demonstrates racial, ethnic, socio-economic and gender balance reflective of the region. [Definition of strong evidence of the criteria, "To what degree does the school provide opportunities for broad participation for a variety of students, including efforts to attract disadvantaged and under-represented student populations?"]

—Ohio STEM Designation Criteria

3.1.A Develops structures and processes for marketing and recruitment to encourage participation from underserved students and families (transportation or plans for transportation to the school, child care for family events, and translation of all recruitment and marketing materials).

3.2.A Develops an admission policy to include an open-access, lottery-based selection process that encourages applications from all students. The application will not be based on state assessment scores, discipline history, teacher recommendation, minimum GPA, or other requirements that would be used to limit selection.

3.2.B Consists of a population that is 50% or greater economically disadvantaged and underrepresented students.

—T-STEM Blueprint

Sources: North Carolina Department of Public Instruction STEM Education Schools and Programs STEM Attribute Implementation Rubric High School. http://www.dpi.state.nc.us/docs/stem/schools/rubrics/high-school.pdf
Call for Proposals for STEM School Designation and STEM School Equivalent for Schools in the State of Ohio, Evaluation Rubric for STEM School and STEM School Equivalent Designation. http://education.ohio.gov/getattachment/Topics/Career-Tech/STEM/Updated-for-K-5-FY18-STEM-Application-Fall-2016.pdf.aspx
Texas Science Technology Engineering and Mathematics Academies Design Blueprint, Rubric, and Glossary. http://www.tstemblueprint.org/uploads/artifacts/benchmark-1/1_-_2015_Blueprint_Final.pdf

III. Develop a system for monitoring and supporting new ISHSs. A structured process and criteria for ISHS designation, with feedback on each school's development, accountability for implementing the blueprint elements, and the potential for revoking the STEM designation enhances the quality of ISHSs and helps them adhere to policymakers' intentions.

Because the blueprints are aspirational in describing a fully developed ISHS or have broad tenets that can be implemented in a range of ways depending on local context and capacity, wide variation can result across local ISHSs. Each state thus has a process to signal that an ISHS meets the state criteria for an inclusive STEM high school.

A STEM school designation process, such as those used in North Carolina, Ohio, and Texas, can reinforce the explicit school structures, curricula, and practices that the state wants to see in its ISHSs as described in the blueprints. So ISHSs don't lose sight of the policy goals, the designation process can serve as an accountability tool. Periodic redesignation (e.g., annually or biennially) affords the opportunity for ISHSs to demonstrate program improvement and reinforces their accountability to maintain the essential elements of the ISHS blueprint. Where prospective or existing ISHSs do not implement the blueprint elements with fidelity—despite feedback and supports—withholding or revoking the STEM designation helps maintain the overall quality of ISHSs statewide. The designation thus helps families know that an ISHS's program actually provides students with access to a high-quality STEM education.

IV. Allocate resources and institutionalize funding. State policymakers can facilitate ISHS development by allocating resources to support local capacity-building.

North Carolina, Ohio, and Texas defined and built infrastructures to support ISHS start-up, development, and sustainability. In addition to fiscal resources, the three states provided knowledge resources in the form of coaching, networks among ISHSs, and technical assistance for specific school needs. Creating new ISHSs to prepare underserved students for college and STEM jobs and careers required new approaches to schooling, as well as an evolving understanding of what STEM education might be if existing barriers to school change were removed. Although some individual ISHSs have been established across the United States without a formal system of technical assistance for their start-up, ambitious

state-level initiatives such as those featured in this brief arguably require new resources to guide the widespread changes they envision.

In addition to ISHS leadership coaching, Texas authorized and funded seven T-STEM Centers across the state. The T-STEM Centers conduct needs assessments with newly designated ISHSs, and early on developed a foundational course for teachers on project-based learning to provide a common understanding of this instructional approach under the T-STEM model. An annual statewide small schools conference highlights innovative practices of ISHSs and provides opportunities for school leaders and teachers to network and learn from each other. The Ohio STEM Learning Network (OSLN) serves as the primary technical assistance provider in that state through a regional hub system, with an ISHS at the center of each hub with higher education and business/industry partners. As a strategy to harness and target resources to improve STEM education, the OSLN hubs provide assistance through collaborations, joint classes, site visits, and educator-to-educator professional development opportunities. In North Carolina, NC New Schools offered technical assistance services to support STEM-focused curriculum development and instruction and connected new ISHSs to higher education and industry partners. NC New Schools closed in 2016, leaving schools to find other means for professional development and technical assistance.

Networking with and learning from other schools with similar missions is essential during ISHSs' first few years as start-ups. Once established, ISHSs may be able to continue their STEM program within a designation process, guided by a blueprint and supported by varying local resources. Even established schools, however, continue to benefit from networking and collaborating with other ISHSs, underscoring the importance of sustained supports to foster ISHS networks.

V. **Create a STEM workforce development plan.** A STEM workforce plan should include strategies for creating a vigorous STEM teaching corps.

All three states in our study noted a shortage of STEM teachers both in ISHSs and for public schools in general. Alternative certification programs in North Carolina, Ohio, and Texas provide avenues for midcareer changers to enter STEM teaching. This provision allows individuals with industry backgrounds in STEM to apply their expertise—with appropriate teacher training—in ISHSs by teaching, developing curriculum, and involving students in internships and other STEM workplace opportunities. Such connections to the workplace are especially important for STEM CTE pathways.

Rural areas in particular may have the most limited STEM labor pool. Thus, they may need policies that encourage midcareer changers to enter the STEM teaching workforce, give STEM teachers the incentive to relocate to rural areas, and offer professional development to enhance STEM knowledge among existing local teachers. Distance education and substantive summer professional development in STEM could further provide rural teachers with access to STEM experiences.

In addition to certification policy, states can help address the salary differential between teaching and industry to attract individuals with STEM industry experience to teaching and to direct them to schools serving students from underrepresented groups. Ohio, for example, offers incentive pay of up to $20,000 for STEM teachers taking positions in hard-to-staff schools; North Carolina and Texas similarly offer various incentive pay programs.

VI. Create a high school-college dual credit system. State policies authorizing and facilitating dual credit courses give ISHSs additional tools to boost curricular rigor and prepare students from underrepresented groups for postsecondary education.

Many ISHSs in North Carolina, Ohio, and Texas offer their students dual credit courses. Indeed, the early college high school (ECHS) model, designed to provide first-generation college-goers the opportunity to graduate from high school with up to 60 college credits (equivalent to 2 years or an Associate's degree), has a robust tradition in all three states. Some early colleges also offer STEM themes, and in Texas a number of ISHSs are combined T-STEM/ECHSs. Advantages of dual credit policies documented in the early college high school research and in research on dual credit programs more generally can apply to ISHSs also. In particular, access to high-level courses for which qualified teachers are scarce, shortened time to postsecondary degree completion, lower cost of a postsecondary education (college credit earned as dual credit does not cost families tuition), and development of a college-going identity among students who otherwise lack the social capital to access college all support the ISHS mission.[3]

State policies that enable districts and higher education institutions to use dual credit provisions effectively include model memoranda of understanding so districts and higher education institutions do not have to negotiate the relevant provisions partnership by partnership; statewide common course numbering to facilitate student enrollment, tracking, and credit transfer; reimbursement for district average daily attendance and college full-time equivalent students so that neither party has a financial disincentive to offering dual credit; and clear certification rules for postsecondary instructors so that high school teachers can be certified to teach dual credit courses.[4] ISHSs in North Carolina, Ohio, and Texas offer dual credit opportunities as an integral component of their STEM curriculum, enabled by these types of supportive dual credit policies.

---

3 See, for example, K. L. Hughes, M. M. Karp, B. J. Fermin, & T. R. Bailey (2005), *Pathways to college access and success,* Washington, DC: U.S. Department of Education, Office of Vocational and Adult Education; and AIR/SRI (2009, August), *Six years and counting: The ECHSI matures,* Washington, DC: American Institutes for Research, http://www.air.org/sites/default/files/downloads/report/ECHSI_Eval_Report_2009_081309_0.pdf

4 L. Cassidy, K. Keating, & V. Young (n.d.), *Dual enrollment: Lessons learned on school-level implementation, Smaller Learning Communities Program,* Washington, DC: U.S. Department of Education, Office of Elementary and Secondary Education, https://www2.ed.gov/programs/slcp/finaldual.pdf; B. Struhl & J. Vargas (2012), *Taking college courses in high school: A strategy for college readiness*, Boston, MA: Jobs for the Future, http://www.jff.org/sites/default/files/publications/TakingCollegeCourses_101712.pdf

Implications for Moving Inclusive STEM Education Forward

As the cases of North Carolina, Ohio, and Texas illustrate, a coherent policy framework facilitating the statewide scale-up of ISHSs requires political intention and vision, widespread cross-sector collaboration, and tangible investment sustained over time. Each of the three states had different building blocks in place and traveled different developmental paths that reflected their state and local contexts.

Drawing on these lessons, other states may forge new collaborations among the governor's office, legislators, the state department of education, higher education institutions, private philanthropy, and industry by determining common interests in STEM workforce and economic development and in equitable STEM education opportunities. States in the early stages of designing an ISHS initiative or those ready for scale-up may begin by assessing the status of policies these three states found facilitative, such as graduation requirements in STEM coursework, dual credit, CTE funding, and teacher credentialing supporting STEM professionals entering education, to identify any policy gaps. Then through targeted and collaborative efforts, key parties can articulate the role of ISHSs in providing access to high-quality STEM education and economic opportunities for students from groups underrepresented in STEM, design ISHSs to fulfill that goal, and mobilize resources statewide and locally to generate policy and capacity that develop and support new schools.

Many paths exist to develop state ISHS initiatives, but the lessons from North Carolina, Ohio, and Texas provide insights into crucial elements—in policy, players, and relationships—that can help other states pursue inclusive STEM efforts more efficiently and powerfully.

Acknowledgements: The authors thank Lauren Cassidy, Marianna Lyulchenko, and Laura Pinkerton on the SRI Education research team for their contributions to the state policy analysis. This material is based upon work supported by the National Science Foundation under Grant No. 1316920. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

SRI Education™
A DIVISION OF SRI INTERNATIONAL

THE GEORGE WASHINGTON UNIVERSITY
WASHINGTON, DC

SRI Education, a division of SRI International, is tackling the most complex issues in education to identify trends, understand outcomes, and guide policy and practice. We work with federal and state agencies, school districts, foundations, nonprofit organizations, and businesses to provide research-based solutions to challenges posed by rapid social, technological and economic change. SRI International is a nonprofit research institute whose innovations have created new industries, extraordinary marketplace value, and lasting benefits to society.

STAY CONNECTED

Silicon Valley
(SRI International headquarters)
333 Ravenswood Avenue
Menlo Park, CA 94025
+1.650.859.2000
education@sri.com

Washington, D.C.
1100 Wilson Boulevard, Suite 2800
Arlington, VA 22209
+1.703.524.2053

www.sri.com/education