VITALSIGNS

Reports on the condition of STEM learning in the U.S.

THE NEXT FRONTIER FOR DATA

The More We Know, the More We Can Do to Improve STEM Learning

"In God we trust. All others bring data."

These words, attributed to the late management guru W. Edwards Deming, sum up a central belief shared by the most innovative and successful U.S. businesses. Without rich and detailed data, companies cannot make informed decisions to serve their customer base and maintain profitability. In the past two decades, educators have increasingly taken this a similar belief to heart to ensure that they develop well-educated young people.

That shared conviction inspired Change the Equation (CTEq), a coalition of nearly 100 CEOs dedicated to improving learning in science, technology, engineering, and mathematics (STEM), to create *Vital Signs* 2012 reports on the condition of STEM learning in every U.S. state and the District of Columbia. These reports offer the richest and most extensive comparable state STEM learning data assembled in one place. The *Vital Signs* provide important insights on strengths and weaknesses in STEM learning in each state. The data and analyses support not only the need for state action, but also specific state policies to improve STEM learning.

However, there still are gaps in the data. This brief describes the data we wish had been available, why those data are important to inform action, and what states can do to gather such data.

The Data We Have

U.S. students' persistent lagging performance in STEM subjects is well documented, prompting fears that they lack the STEM knowledge required for a new wave of jobs, whether in or beyond traditional STEM fields. They fall behind their peers in many other advanced countries in both international tests and their likelihood of earning postsecondary degrees in STEM fields. Such broad data on outcomes are important, but they do not offer clear guidance for action. Simply admonishing schools and afterschool programs to try harder isn't much of a strategy.

Fortunately, states have made swift and remarkable strides in data collection over the past decade. The Data Quality Campaign reports that more states are putting data systems in place that will allow them to track young people's progress from early childhood, through K-12, and into college and careers.[1] States can use such systems to pinpoint and address areas of weakness in the learning pipeline. Yet despite these advances, much important data on states' progress in STEM learning remain hard to find, even for business leaders, state policymakers, community leaders, and families with a big stake in the results.

CTEq fills some of the gaps with its *Vital Signs* reports, which aim to answer the following questions for every state and the District of Columbia:

- What is the demand for STEM skills and knowledge?
- Are young people learning those skills and that knowledge?
- Are states' academic standards and expectations for student performance aligned to the demand for STEM skills and knowledge?
- What access do young people have to opportunities to learn STEM skills and knowledge?
- How well are educators prepared to teach STEM skills and knowledge?
- Do schools and educators have the capacity and get the support they need to reach their goals?

The *Vital Signs* reports present tens of thousands of data points on STEM learning. They also break substantial new ground, offering compelling data in areas such as the demand for STEM workers, state standards for student proficiency in science, students' access to challenging coursework, the cost of college remediation in math, and the return states get on their investment in math and science education.

CHANGE THE EQUATION™

Yet the reports also have blind spots where state-by-state data on crucial aspects of STEM learning were simply unavailable or devilishly hard to find. What's more, the data the reports do present may be eclipsed by better data down the road. As new math and science standards and better tests come online, for example, we will have more sophisticated state-by-state data on how students are really doing in these subjects. As states improve their systems for measuring teachers' impact on student performance, we will have more detailed information on how effective teachers are, and how states can help them become more effective.

However, we do not have the luxury of waiting for the perfect data to come along before acting decisively to improve STEM learning.

The Next Frontier of Data

While creating the *Vital Signs* reports, we were acutely aware of the next frontier for STEM learning data; data that could fill out the picture of how states are doing and more effectively inform their efforts to do better. Leaders in business, community organizations, education, and state policy can help move us to this next frontier.

The Demand for STEM Skills

The *Vital Signs* reports demonstrate that the market for STEM workers has remained strong, and most projections forecast growth in the number of jobs that require STEM skills. Still, there is much we don't know. For example:

- **What STEM skills and knowledge do high-demand jobs require?** STEM skills are not monolithic. Some are in higher demand than others, and the demand for specific skills changes over time. We lack timely and reliable data on what skills are in highest demand, regardless of job title, and the difficulty employers have in finding those skills.
- **How can states tailor their education and workforce development strategies to better match the current and expected needs of employers in the state?** Because we lack reliable data on what skills are in highest demand, we lack the ability to tailor strategies to create stronger and more effective school to career pipelines.

New sources such as databases of unemployment insurance records and websites that collect and analyze online job postings are growing more sophisticated and may soon provide better real-time answers to some of these questions. Some states have begun to mine these systems to inform their workforce development efforts. As the systems grow more robust, more states should publicly report data on the supply of and demand for STEM skills.

The Supply of STEM Skills

The *Vital Signs* examine the pipeline of STEM skills through indicators describing student performance and persistence in high school and college. Yet we still need to know more to strengthen our efforts to plug holes in the STEM pipeline:

- **How well are high school students doing in STEM subjects?** We have no common, reliable measure for judging how high school students in all 50 states and the District of Columbia are faring in math and science. The new common tests many states are working together to create, which include tests of eleventh graders, may help fill that gap. States should stay the course on these tests.
- **How well might new assessments match the STEM knowledge and skills needed for success in the workplace?** Many current state tests do not effectively assess the higher-order and applied skills employers prize. The new common tests promise to measure such skills more effectively and therefore provide richer data on how well students are being prepared for jobs in highest demand.
- **How many students are leaking out of the STEM pipeline?** We do not have state-by-state data that allow us to trace a single cohort of students through K-12 into college and the workforce and therefore assess when, where, and why they're leaving the pipeline. The Data Quality Campaign reports that some states have laid the groundwork for systems that track students' trajectories from school to college and career. Other states should follow their lead.
- **What is the full cost to states of college remediation in math?** Sixteen states were unable to supply critical information on how much they have to pay to educate students twice on the same content—once during K-12 and once after high school. Paying twice is unacceptable. States should measure and report how much math remediation costs taxpayers, and these data should become a critical public measure of how well they are preparing their young people for college.

Access to Engaging and Challenging STEM Learning Opportunities

The *Vital Signs* reports include many indicators about students' access to such opportunities, yet more and better information would help us ameliorate critical gaps or inequities in such access. For example:

- **How many students are taking challenging STEM courses in high school?** What are the participation rates for female and minority students? For example, it is all but impossible to determine how many high schoolers graduate having taken Algebra II, Physics, or Calculus, or how many are

encouraged by parents, teachers, and counselors to take advanced courses. States should publish aggregate data on the courses students complete in middle and high school, broken down by race, ethnicity, and gender.

- **Are courses as challenging as their course titles suggest?** It is even more difficult to determine whether course titles actually correspond to rigorous course content. In some schools, titles like "Algebra I" or "Algebra II" can conceal diluted content. States should follow the lead of Rhode Island and Delaware in auditing the content of those courses to ensure they actually match their course titles.
- **What STEM learning opportunities do K-12 students have in technology and engineering?** The likely answer to this question is not many, yet we lack state-by-state data to prove that assertion. What we have learned from a handful of national surveys is troubling: Fewer schools offer computer science than seven years ago,[2] and few teenagers have had much exposure to engineering.[3] States should publish course-offering and course-taking information in computer science at a minimum. In addition, those that adopt common Next Generation Science Standards, which include engineering content and practice, will have an opportunity to assess students' grasp of fundamental engineering concepts. Once the new standards and aligned tests are in force, states should publicly report student outcomes in engineering.
- **How many students are participating in challenging and relevant Career and Technical Education (CTE) programs in high school?** State-by-state information on student participation in CTE programs is scarce, yet CTE programs can offer an essential pathway to postsecondary education and STEM careers. States should collect and report data on how many students participate in CTE and how well they fare in college and careers.
- **How many students have access to out-of-school programs in STEM?** There are no state-by-state data on how many students participate in STEM learning programs out of school. We also know very little about the quality of that programming or how widespread it is at the state level. States could, at a relatively modest cost, survey students or their families on their exposure to STEM learning opportunities outside the school day.

Effective STEM Educators

Data on the effectiveness of STEM teaching is especially hard to come by. The *Vital Signs* reports used two proxy measures for teacher effectiveness that, research tells us, are associated with higher student performance—teachers' content background in the subject they teach and the number of years they have taught their subjects. Important as those measures are, they don't fully answer the more essential questions about the actual impact of teaching and teacher preparation:

- **How effective are teachers in improving student learning in STEM subjects? Who has access to the most effective teachers?** Most states are developing systems to measure individual teachers' impact on the performance of the students they teach. Those efforts are still in their early stages, and it will be several years before they yield reliable and comparable state-by-state data on which students have access to effective teachers. As states design these systems, they should consider their potential to inform state policies to attract and retain excellent STEM teachers, especially in low-income schools, which need them most.
- **How effective are programs to prepare new teachers?** Efforts are underway to link K-12 students' achievement data to the programs that prepared their teachers to measure those programs' impact. In addition, 25 states are working with Stanford University and the American Association of Colleges for Teacher Education to create a performance assessment for new teachers that may produce new information on the productivity of teacher preparation programs. Those efforts also are too new to produce state-by-state data, but they have the potential to help state leaders and other stakeholders strengthen teacher preparation statewide.

Support for Schools and Educators

The *Vital Signs* reports include data on teachers' and schools' access to critical resources and facilities. Yet here too, questions remain:

- **How effective is professional development for STEM teachers?** While state and national data allow us to estimate how much professional development STEM teachers receive, we know precious little about the

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quality. Some states, such as Arizona, are evaluating how their teacher professional development measures up against the widely-embraced Standards for Professional Learning developed by Learning Forward, an association of staff developers in education. Other states, such as Florida and Massachusetts, have begun to measure the impact of professional development by linking it to student achievement data. States across the country should emulate these efforts.

- **How well are states supporting the implementation of new standards and tests?** Information is scarce on what individual states are doing on the ground to ensure that their implementation of the new rigorous standards is effective. Are they creating strong new curricula, teaching materials, and tailored professional development that support the new standards? Are their teacher preparation programs adapting to the new standards? Are they preparing parents for the changes that are in the works? New standards have tremendous promise, yet they will likely fall flat if states do not address these critical questions. States that are adopting new standards, including Common Core State Standards, should publicly define, and regularly report on, clear metrics for the implementation of those standards and tests.

What We Don't Know Can Hurt Us

By shining a light on what we know about STEM learning in every state, CTEq's *Vital Signs* reports aim to help STEM learning advocates in states promote the kinds of policies and practices that will boost the performance of all their students. Yet we also need to spotlight what we still need to know. Business, community, and education leaders are eager to collaborate with state leaders to make a difference for students in their states. States can do more to illuminate their path.

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[1] See www.dataqualitycampaign.org.

[2] Computer Science Technology Association, *CSTA National Secondary Computer Science Survey, 2011*, accessed on September 1, 2012 at http://csta.acm.org/Research/sub/Projects/ResearchFiles/CSTASurvey11CSResults.pdf.

[3] Intel, "Exposure to Engineering Doubles Teens' Career Interest," December 6, 2011, accessed on September 1, 2012 at http://newsroom.intel.com/community/intel_newsroom/blog/2011/12/06/exposure-to-engineering-doubles-teens-career-interest

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Change the Equation (CTEq) is a nonprofit, nonpartisan, CEO-led initiative that is mobilizing the business community to improve the quality of science, technology, engineering, and mathematics (STEM) learning in the United States. Since its launch in September 2010, CTEq has helped its nearly 100 members connect and align their philanthropic and advocacy efforts so that they add up to much more than the sum of their parts. CTEq's coalition of members strives to sustain a national movement to improve PreK-12 STEM learning by leveraging and expanding its work focusing on three goals: improving philanthropy, inspiring youth, and advocating for change.

www.changetheequation.org

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