REFUELING THE U.S. INNOVATION ECONOMY:
Fresh Approaches to Science, Technology, Engineering and Mathematics (STEM) Education

by Robert Atkinson and Merrilea Mayo | Information Technology and Innovation Foundation | December, 2010

Innovation has powered America's economy, creating good jobs and a high standard of living. Yet, the U.S. share of innovation-based industries is in decline, jeopardizing our status as the world's innovation leader. And one reason is that the United States has been unable to produce enough of its own workers with sufficient skills in science, technology, engineering and math (STEM). However, while there is increasing concern over how to increase STEM graduates, the prevailing approaches to solving the STEM challenge have not worked and are not likely to work. It is time for new approaches based on driving innovation in STEM education. This report discusses the limits of the prevailing approaches and outlines fresh approaches and specific policy recommendations to address America's STEM challenge.

LIMITATIONS OF THE CURRENT "SOME STEM FOR ALL" APPROACH

The prevailing approach to STEM policy can be characterized as "Some STEM for All": ensure that all students get as much STEM as possible at each step in their education. From this assumption, most reform proposals are based on one of three core strategies: boosting STEM teacher quality and improving curriculum, imposing more comprehensive STEM standards, and getting students excited about STEM. The assumption is that many jobs will require STEM skills and that we can't afford not to give every student the best STEM education.

The logic of this an approach is appealing, as evidenced by the fact that it is so widely embraced. However, this report argues that it suffers from a number of key limitations. First, only a small share of workers (5 percent) are scientists and engineers. Yet the "Some STEM for All" approach would ensure that all students have the best STEM education that money can buy. Not only are big new expenditures on STEM not likely, but even if we could marshal more resources, they won't solve the problem. New kinds of institutions and incentives for change, including better information on the performance of educational institutions, will.

A second limitation of "Some STEM for All" is that it works against, not for the central enabler of effective STEM education: motivated students. Instead of moving our educational system to one that respects the desires of students to be active learners, we are going in the opposite direction, seeking to impose more subject matter requirements and tougher content-based standards because we presume that students are unwilling to learn unless required to. Forcing students to take more math and science courses, pass more standardized tests, and memorize more facts won't make them more likely to become STEM workers. In fact, telling students what they have to know and giving them almost no opportunity to follow their own unique interests is a recipe for today's alarmingly high levels of high school dropouts. It is also a recipe for mismatch between STEM jobs and STEM education. Over 80 percent of STEM jobs are in engineering and information technology, yet engineering and computer science are barely present, even in high school. Allowing students access to a rich array of STEM disciplines—including those actually needed for STEM jobs—is one necessary step in needed reforms.

THE OUTLINES OF A NEW "ALL STEM FOR SOME" APPROACH

After more than 40 years of trying the "Some STEM for All" approach to little avail, it's time to shift direction. This report lays out a blueprint that transforms a weak "Some STEM for All" approach into a more powerful, less costly, and more socially equitable "All STEM for Some" approach. It is based on working to actively recruit those students who are most interested in and capable of doing well in STEM (including currently under-represented groups) and providing them with the kind of educational experiences they need to make it through the educational pipeline and come out able and willing to contribute to growing the U.S. innovation economy.

This report discusses why STEM is important (Chapter 2) and why we have a shortage of domestic STEM workers (Chapter 3). It then discusses the limitations of current "Some STEM for All" approach (Chapter 4) and why we need to shift to teaching STEM skills, not STEM facts (Chapter 5). It then proposes how to increase the quality of STEM education, by creating more "Deep Divers" in high school (Chapter 6) and Interdisciplinary Connectors and Entrepreneurs in college (Chapters 7 and 8). It then discusses strategies for expanding STEM graduates (Chapter 9) and reducing skill and job mismatches (Chapters 10 and 11). Finally, Chapter 12 lays out 35 policy recommendations based on what we term the five I's. Some of these recommendations are listed here:

EXECUTIVE SUMMARY

Interest: There is perhaps no more widely held view in the STEM community than the one that says that we know what students should learn and that the best way to get more STEM graduates is to require every student to take more STEM classes. But an education system, particularly in high school, that ignores the interests of learners is one that is destined to fail. A more effective route is to create a system where student interests in STEM drives what is offered. This means dramatically reshaping high school education to many fewer requirements and much greater opportunity to explore a wide variety of STEM subjects and changing the way STEM is taught in higher education. To do this we should:

- Shift accountability measures for high schools from a content-based (e.g., NAEP and NCLB subject-matter-based tests) to skills-based paradigm.
- Reduce course requirements to provide students the opportunity to pursue depth in their K–12 studies, including STEM.
- To help reduce the freshman STEM student drop-out/switchout rate the President should issue an Executive Order requesting that at least 30 percent of federal agency-funded undergraduate research experiences be moved to the freshman year and summer following.

Institutions: The best and easiest way to produce more and better STEM graduates is to create new institutions that can provide high-quality, best-in-class STEM education. To do this we should:

- Fund the Department of Education to create 400 new specialty STEM high schools.
- Establish a STEM talent recruiting system by ensuring that the hundreds of outreach coordinators managing the hundreds of federal agency high school outreach programs sites actively work to recruit students with an interest in STEM to the right opportunities for STEM education.

Incentives: While more information about what works in STEM education is helpful, much of what works is known. What are lacking are incentives for educational institutions to adopt these best practices. Policy needs to provide incentives – both carrots and sticks—for institutions to move to STEM best-practice, including:

- Appropriate $100M a year to NSF for five years, to be matched 1:1 by a major philanthropy for prizes for colleges and universities who have best expanded STEM graduates.
- Allocate NSF and NIH grants for up to $20M/year to colleges for institutional transformation, especially focused on a more interdisciplinary model of STEM education.
- Replace federal grant award criteria that preserve higher education's overly rigid focus on disciplinary stovepipes with criteria that are at least neutral towards interdisciplinary, novel, and industry-friendly work.

Information: When consumers have better information they make better decisions, which put pressure on organizations to provide better services. Yet, in many areas of STEM education, information is lacking. Policy needs to drive much better information about STEM educational institution performance and ensure that this information is widely available. We should:

- Require all colleges and universities receiving federal money to report results from the National Survey of Student Engagement, a survey that measures practices associated with superior educational outcomes.
- Ask industry to rank university STEM departments based on the quality of students as future employees.

Industry: One reason the education system has not produced the kinds and numbers of STEM graduates needed is that it has attempted to accomplish this task in isolation from industry. Closer links to industry, particularly at the undergraduate and graduate levels, would go a long way to encouraging more students to learn the kinds of skills most needed to drive innovation. We should:

- Target a significant share of increases in federal research funding to university programs that partner with industry since partnerships not only spur more innovation, they boost STEM education outcomes.
- Create an "NSF-Industry Ph.D. Fellows Program" where industry and NSF match funds to support Ph.D. fellowships in fields companies choose.

CONCLUSION

As other nations make the investments needed to grow their innovation economies, the United States is rapidly losing ground. There is time to turn this around, but perhaps as soon as a decade from now, no matter how attractive we make STEM education, even fewer Americans will want to go into it because they believe that the job opportunities will not be sufficient. If this happens, there will be fewer STEM jobs, leading to even fewer STEM students, all until some lower, and less prosperous equilibrium is achieved. Taking bold steps to reinvigorate STEM education is needed to help avoid this fate. The key question is whether we as a nation will be able to take these steps with the imagination, creativity and boldness needed. Only time will tell. For the sake of our children, let's hope the answer is yes.