STEM for All Students: Beyond the Silos

A White Paper from Creative Learning Systems

Defining the Challenge

Today's world requires that *all* students obtain a solid foundation in STEM (science, technology, engineering and math). Gone are the days where students we deem non-college material are served best by teaching them to "work with their hands". Virtually every job requires proficiency in applied technology and a growing number of careers involve applied math and science. Moreover, it is the integration of STEM disciplines, the ability to apply knowledge to workflow along with 21st century skills such as communication and collaboration, critical thinking and problem solving, information literacy and adaptability that are most critical to success in a fast-paced global economy.

While this need is widely recognized by educators and public policy experts, solutions often miss the mark. Instead of an integrated approach focused on applied knowledge, we continue to emphasize knowledge in silos; the "s", the "e", the "m" - and whatever "t" exists is most often put in the hands of teachers, not students. This approach may be easiest, since it is consistent with traditional educational approaches and structures, but it does not meet the post-secondary and career readiness needs of the vast majority of our students.

The Limits of the Silo Approach and Pre-Engineering Programs

More math and science courses are not the answer for most students. In most schools, our best math and science students already have ample opportunity to advance their education while in secondary school. The more difficult and critical challenge is engaging a broader base of students in STEM. For example, the recent report from the Presidents Council of Advisors on Science and Technology (PCAST) highlighted the achievement gap between demographic groups in STEM education and noted that, "African Americans, Hispanics, Native Americans, and women are seriously underrepresented in many STEM fields." The report also noted that, "It is important to note that the problem is not just a lack of *proficiency* among American students; there is also a lack of *interest* in STEM fields among many students." [1]

Particularly puzzling is the recent adoption by many public schools of pre-engineering programs such as Project Lead the Way (PLTW) and The STEM Academy. According to its website, Project Lead the Way currently serves over 300,000 students in nearly 3,500 schools in all 50 states. A new program, The STEM Academy, also reports widespread interest in adoption of their pre-engineering programs. Both offer well-researched, rigorous programs to prepare students for a post-secondary education in engineering. The question, however, is whether these programs primarily serve a small segment of top math and science students (substantially white males) and ignore the broader goals of STEM education for all students.

Consider the following educational statistics: An estimated 30% of new high school students in the US do not graduate with their class. Of the 70% that do graduate, approximately 55% continue on to pursue a post-secondary degree. Approximately 4% of entering freshmen in US degree-granting institutions enroll in engineering and engineering technology programs. [2] *Why then are we committing such a significant proportion of increasingly limited educational resources to serve a mere 1.5% of our secondary student population?*

Much of the political impetus behind these programs derived from the report, *Rising Above the Gathering Storm: Energizing America for a Brighter Economic Future* published by the prestigious National Academies Press. This report pointed to trends in the numbers of engineering graduates in the US compared to emerging global competitors like China and India. It predicted dire consequences to US competitiveness as a result. While the need for increased focus on STEM education is undeniable, much of the basis for the report's conclusions and policy recom-

mendations have come under fire. Apparently, the statistics upon which the conclusions of the National Academies report were based originated from a Fortune Magazine article using significantly flawed and non-comparable statistical data. Rather than verify those statistics, the author of the National Academies report "assumed Fortune Magazine did fact-checking on their numbers". [3]

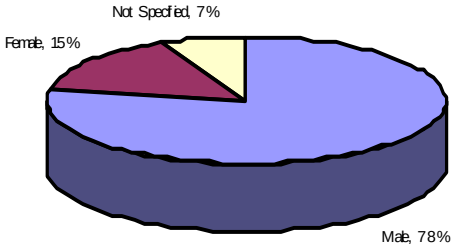
Indeed, a study by the Duke University Master of Engineering Graduate Program, concluded that, "inconsistent reporting of problematic engineering graduation data has been used to fuel fears that America is losing its technological edge. A comparison of like-to-like data suggests that the US produces a highly significant number of engineers, computer scientists, and information technology specialists, and remains competitive in the global marketplace". And a follow-up report by the same researchers concluded, "In an analysis of salary and employment data, we did not find any indication of a shortage on engineers in the United States."[4]

Another important concern is whether these programs primarily benefit the top math and science students – a small segment of the school population that is generally not considered to be underserved. One pre-engineering program defines its impact by citing statistics such as 80% of high school seniors enrolled in the program "say that they will study engineering, technology, or computer science in college whereas the national average is 32%". However, there is no reported data suggesting that this outcome was not self-selective and that these students would not have pursued these fields in any case. This is in spite of the recommendation of a 2006 evaluation prepared for the same organization that reported similar survey results but stressed that "it is imperative to address the question of whether [program] students are all self-selected high achievers who would go to college and study engineering anyway".[5] Moreover, there is no data suggesting benefits for the majority of high school students who do not pursue a post-secondary education.

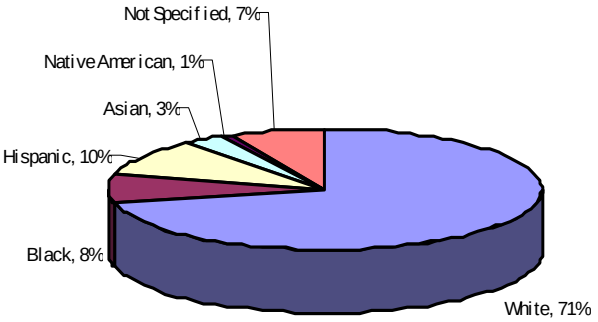
The 2006 evaluation study also examined diversity in the pre-engineering program enrollments. Only 17% of pre-engineering enrollments were female. The report concluded that, "Females would have to triple their enrollment in [program] courses to reach proportional representation. This remains a significant problem."

The study also found that 71% of student enrollments were white (compared to 66% in college engineering programs). African Americans and Hispanics represented 8% and 10% of program enrollments respectively.

PLTW Enrollments By Gender



PLTW Enrollments By Race/Ethnicity



Conclusions

If schools are to pursue a mission of promoting STEM education for all students, they must adopt programs that appeal to a broader student population. This requires STEM curriculum for learners of *all* abilities, backgrounds and interests.

Pre-engineering programs like Project Lead the Way and The STEM Academy are well-designed, rigorous programs developed and supported by reputable organizations and backed by significant political support and government/foundation funding. These programs help prepare learners to successfully pursue a post-secondary engineering degree. However, schools that adopt these programs, as well as those that implement additional high-level math and science course, must recognize that these programs are primarily targeted towards the highest achieving math and science students and that these students are predominantly white and male.

Creating an interest in STEM among a broader base of students, especially women and minorities requires a new approach. The first challenge is to engage learners in STEM subject matter. STEM content must meet today's learners where *they* are – both with respect to interests and abilities. It must be relevant and engaging. It must utilize current technology and modes of communication. And it must be *integrated*. When we talk about the need for increased emphasis on STEM, we cannot simply default to traditional content silos, building separate programs around **s**cience, **t**echnology, **e**ngineering, or **m**athematics. Rather, it is the *intersection* of these disciplines (and indeed the further integration of social studies, language arts and fine arts) that has the power to engage students with diverse interests, abilities and backgrounds and prepare *all* learners to succeed in global economy.

Works Cited:

[1] *Report to the President – Prepare and Inspire: K-12 Education in Science, Technology, Engineering and Math (STEM) for America's Future*, Presidents Council of Advisors on Science and Technology. September, 2010.

[2] National Center for Education Statistics, *Digest of Education Statistics, 2008*; The Manhattan Institute, *High School Graduation Rates in the United States - Revised, 2002*; American Association of Engineering Societies, Engineering Workforce Commission, Engineering and Technology, *Science and Engineering Indicators – 2002*.

[3] Bialik, C. (2005). "*Sounding the Alarm with a Fuzzy Stat*." The Wall Street Journal Online, October, 2005.

[4] *"Framing the Engineering Outsourcing Debate: Placing the United States on a Level Playing Field with China and India"*, Wadhwa, Gereffi, et al. Duke University, December, 2005.
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[5] *Program Evaluation of Project Lead the Way, 2005-2006*, Presented to Project Lead the Way, By Douglas Walcerz, President, Outcomes Assessment Solutions, LLC.