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Ideas in Action

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Ensuring that Florida's university-bound high school graduates are STEM-ready - prepared for undergraduate programs in science, technology, engineering, and mathematics

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According to the report *Closing the Talent Gap* released by the Florida Council of 100 and the Florida Chamber of Commerce in January 2010, our state will need "100,000 more science and technology professionals than we are on track to produce" during the next five years. Of the 50,000 bachelors' degrees awarded by Florida's public universities each year, only 8,500 students are in STEM (science, technology, engineering and mathematics) fields. The state's independent colleges and universities add another 1,200 bachelors' degrees in engineering and information sciences to the total. Because the number of STEM bachelors' degrees produced each year in Florida is so small compared to the shortfall, it is clear that meeting Florida's needs for science and technology professionals in the next decade will require a major shift in the culture and priorities of the state's educational system. Under the New Florida Initiative being pursued by the State University System's Board of Governors, a substantial investment will be made in building the capacity of the state's universities to educate STEM professionals.

However, the New Florida investment will be wasted unless Florida's public high schools dramatically increase the number of students they send to our universities who are both interested in science and engineering careers and well prepared for the rigor of undergraduate programs in those fields. Doing so will require our high schools to recast their missions. The core science subjects of biology, chemistry, and physics must become central to our high schools' curricula and the preparation of every university-bound graduate for rigorous undergraduate programs in science and engineering fields must become a high priority for each high school. This imperative must be as high a priority as raising graduation rates. While the new high school graduation requirements in math and science, passed by the Florida Legislature in 2010 and signed into law by Governor Crist, are an important step forward in making sure that every high school graduate is mathematically and scientifically literate, they do not accomplish the goal of making sure that every university-bound student has a comprehensive preparation in all the core science areas of biology, chemistry, and physics.

The change necessary in the culture of our high schools was illustrated by a conversation *Orlando Sentinel* reporter Leslie Postal had with an Orange County ninth-grader named Haley about the new high school graduation requirement that students take either chemistry or physics. In an article published April 22, 2010, Postal reported that Haley expressed an interest in more advanced life sciences classes like Anatomy and Physiology, marking her

as a possible future health professional Then Haley complained about the new chemistry-or-physics requirement, saying, "Other courses are just so much more interesting…Not all careers do you need to know chemistry and physics."

However, if Haley is heading for a career as a pharmacist, physical therapist or physician, she will have to deal with *both* chemistry and physics in college, in addition to a heavy load of the life science courses in which she professes an interest. The undergraduate preparation for each of these three careers includes two semesters of general chemistry, at least one semester of organic chemistry and two semesters of general physics. Common sense says that students who have taken strong high school courses in chemistry and physics are more likely to succeed in the college-level chemistry and physics classes, and research backs that conclusion up.[1]

In high demand university courses such as General Chemistry, General Physics and Organic Chemistry, the failure of a student to prepare properly often has financial consequences, both for the university (and therefore taxpayers if the university is public) and the student. If the student earns a grade of "D" or "F", she or he must repeat the course, extending the student's time to graduation and keeping another student from taking the class in a timely fashion. If the student earns enough D's or F's, she or he can be forced to change career plans altogether, costing the state one more STEM professional.

A study published by researchers from the Alliance for Applied Research in Education and Anthropology at the University of South Florida in 2007[2] showed just how important a complete core of math and science courses is to high school students such as Haley who are considering STEM careers. The study took advantage of Florida's state-of-the-art student databases and concluded that, "enrollment and attainment in physics and calculus is particularly important for all students with respect to obtaining a STEM degree down the road."

However, the USF researchers found an even more striking result when they examined the impact of advanced high school courses in mathematics and science on minority students:

> *Somewhat surprising and most encouraging, the results of our analyses show that minority students who are prepared for STEM degree attainment by virtue of taking high-level science and mathematics courses, particularly calculus, chemistry, and physics at the highest levels, are more likely to persist through STEM coursework in college than their White counterparts and obtain a STEM degree. Those African American students with higher level coursework preparation who persevere in pursuing the pathway toward obtaining a baccalaureate degree are just as likely to obtain STEM degrees as their White peers who also complete baccalaureate degrees. Similarly, Hispanic students with advanced level course preparation are also more likely than White students to persist to obtain a STEM degree.*

This conclusion from the USF report is important, because African-Americans and Hispanics are strongly under-represented in the STEM professions. Therefore, Florida's minority population is an enormous untapped resource for the state's economy.

Our concerns about STEM-readiness should not be confined to students like Haley who set their sights on STEM careers in high school or before. No one would suggest that students should be held to career choices they make when they are 15 years old. Yet a talented high school student who decides to forgo chemistry or physics classes

1 Philip M. Sadler and Robert H. Tai, *Science*, Vol. 317, Pgs. 457-458 (2007).

2 W. Tyson, R. Lee, K.M. Borman, and M.A. Hanson, *Journal of Education for Students Placed at Risk*, Vol. 12, Issue 3, Pgs. 243-270 (2007).

because of a conviction that she or he will be pursuing a career in the arts is cutting off an important range of career options. In fact, it is not uncommon for upper division university students to realize that they find a STEM career attractive but that they have massive math and science deficits that stretch all the way back to their high school days.

How can we make sure that our best and brightest – our university-bound high-school graduates – are well-prepared for the rigors of undergraduate programs in science and engineering? Unfortunately, the present system that relies on students obtaining advice from parents, teachers, guidance counselors and peers is not working. As evidence of this, consider the fact that the fraction of 2008-09 Florida high school graduates who had taken Physics 1 or its equivalents – 22.8% – has been declining since the 2004-05 school year.[3] While the new high school graduation law, which requires "chemistry or physics," will have a dramatic effect on the chemistry course-taking rate (which had been holding steady at about 65%), it is less likely to increase the physics course-taking rate since chemistry is generally listed as a prerequisite for physics in Florida's school districts.

It appears that to achieve the goal of dramatically increasing the number of STEM-ready university-bound students a new incentive will have to be put in place. There are three policy options for providing such an incentive:

1) **Initiating a program of differentiated high school diplomas**

Florida can initiate a program of differentiated high-school diplomas like that recently adopted in Virginia. The highest-level diploma -- which in Virginia is called an "Advanced Studies Diploma" and is intended for university-bound students -- should require that each graduate take courses in biology, chemistry and physics. The same bill (SB 4) that installed Florida's new high-school graduation requirements also called for a study of differentiated diploma options by the Florida Legislature's research and analysis unit, the Office of Program Policy Analysis and Government Accountability. The report will be completed in time for the Legislature to consider this option during its 2011 session.

2) **Modifying requirements for Bright Futures Scholarships**

The eligibility requirements for Bright Futures Scholarships could be modified to require biology, chemistry and physics. Bright Futures is an immensely popular program among voters, and steps taken the last few years to arrest the rapid increase in the program's budget have already incited considerable grumbling among university students and their parents. It may be unlikely that legislators would be willing to tighten the eligibility requirements further at this time.

3) **Requiring high school biology, chemistry and physics for admission to the state's public universities**

Requiring a full slate of science courses for university admission is the most direct way of ensuring that every university-bound student is STEM-ready. However, the state's universities have been emphasizing the issues of accessibility and graduation rate. The Florida Board of Governors, which would have to make the change to admissions requirements, might not be willing to impose additional graduation requirements in science because of the possible perception that they would be limiting access to the universities.

All three of these options face significant political obstacles. However, it is likely that the Bright Futures option faces the steepest obstacles of all because the scholarship program is such a hot button issue with middle class voters.

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3 Percentage supplied by the Florida Department of Education and reported in the *Orlando Sentinel* education blog *School Zone.*

Making sure that every university-bound student is STEM-ready isn't just about preparing the scientists, engineers, and mathematicians needed to keep Florida's high technology industries fed. It is also about providing the greatest possible range of opportunities for Florida's students. In the future, the state's highest paying and most secure jobs will be concentrated in the STEM fields. It only makes sense to be sure our best and brightest don't cut themselves off from these opportunities while they are still in high school.

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