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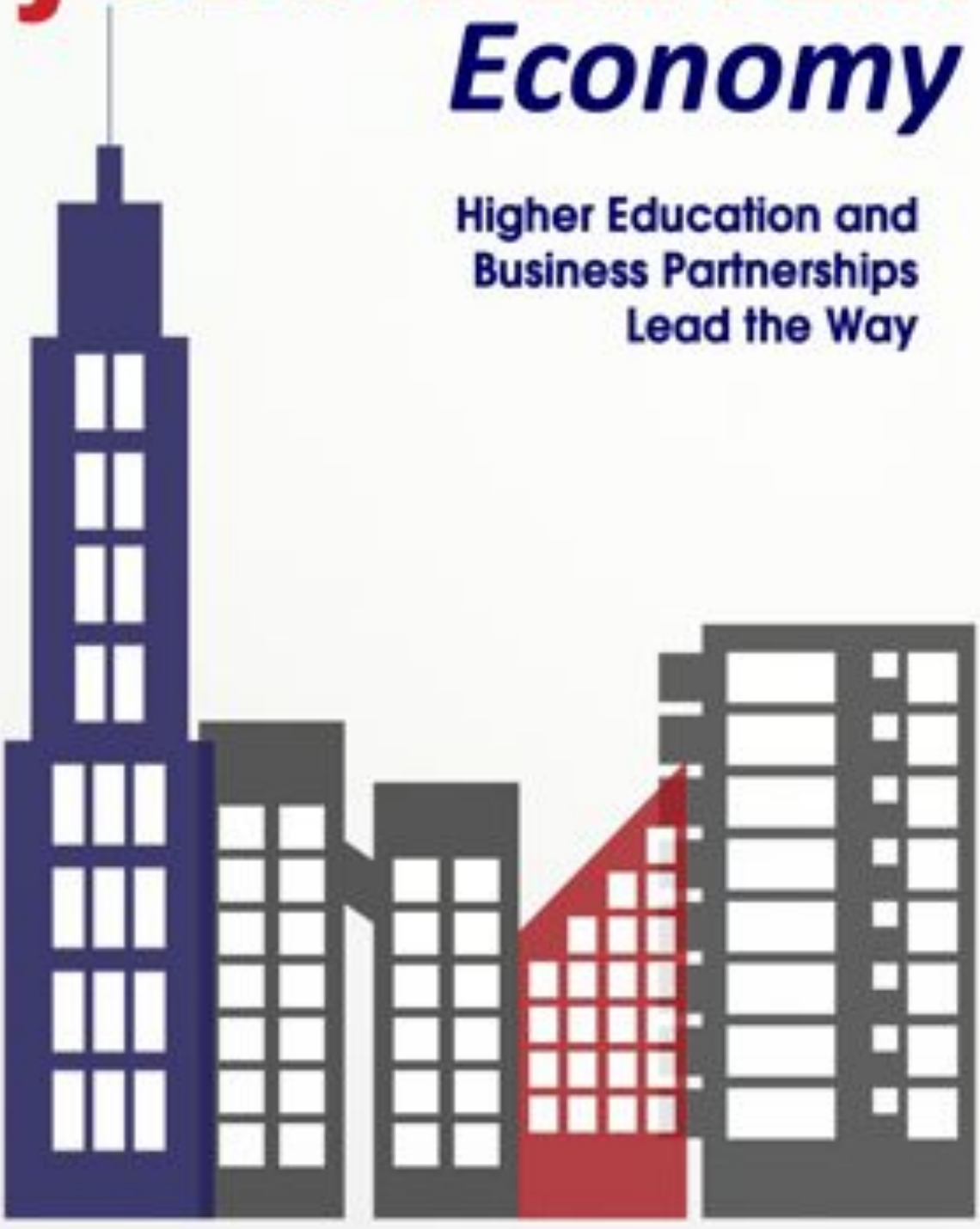

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Changing the Culture of STEM Education to Improve Student Success

By: Dr. Freeman A. Hrabowski, President, University of Maryland, Baltimore County

A few years ago, I chaired a study committee at the National Academies that wrote *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. The committee was tasked with examining how to improve the participation and success of underrepresented minorities in STEM as a follow–up to the Academies' Rising Above the Gathering Storm. While examining that problem, we uncovered another: colleges and universities are failing students in STEM from all racial and ethnic groups.

Of course, it did not surprise people that underrepresented minorities did not fare well in undergraduate STEM. Only about 20 percent of Blacks and Hispanics who start as STEM majors graduate with degrees in these fields. What did surprise people was that the numbers for white and Asian American students – 32 percent and 41 percent, respectively – were not much higher.

When shown these numbers, university faculty and administrators typically argue that the problem lies with preparation and K–12 needs to fix it. But researchers have probed further into the data and found, when considering student success in STEM, that the higher the SAT scores, the larger the number of AP credits earned, and often the more prestigious the institution, the greater the chance that a student who starts in STEM will leave it within the first year or two.

I noted this recently at a meeting with a federal agency, and later one of the top executives came up to me and said, "You just told my story. I was the valedictorian of my high school class, I had near perfect SATs, I chose to major in chemistry in a very prestigious university, and I had planned to go to medical school. By the end of my first semester in college, I had earned an A in each of my classes but Chemistry, in which I earned a C. When I went home at the end of the semester I told my parents and everyone else that I loved English and was changing majors."

We need to look in the mirror and acknowledge that while there are problems with pre–college preparation, the high attrition rates in STEM pose a major problem for undergraduate STEM education. We all know that in most colleges and universities, introductory courses in mathematics and the natural sciences are seen as "weed out" courses. We've all heard the statement, "Look at the student to your left and now look at the student to your right. One of you will not succeed in this course." On our campus, we say, "Look at the student on your left and now look at the student on your right. Our goal is to make sure all three of you succeed and if we don't, then we fail. And we don't plan to fail."

As a nation, we are falling behind. If you look at the proportion of 24–year–olds who have earned a first university degree in the natural sciences or engineering, several European and Asian countries are at 10 percent or higher for this demographic group. In the U.S., we are at just 6 percent. We must act in tackling the problem of attrition from undergraduate STEM majors; this is the place to start.

Course Re–design

On a recent flight, I read a short piece by Gary Kelley, Chief Operating Officer of Southwest Airlines, in which he described his company's *secret sauce*. He said, "Your business plan is what you are, but culture is who you are." Indeed, your culture embodies the values you hold, the assumptions you make, the questions you ask, and what you reward and what you don't reward. For colleges and universities, our challenge is to put students first. In order to address this critical problem of attrition in undergraduate STEM education, faculty and administrators need to change the culture of teaching and learning in our institutions to support student success.

At UMBC and other institutions in the University of Maryland System, we are changing this culture by better understanding how students learn, and redesigning our introductory courses to facilitate better teaching and deeper learning. We argue that quality is not measured by how many students you weed out, but by setting a high standard and then supporting your students so they can attain and surpass that standard.

The classroom approaches we are employing as we re–design our courses include supplementing or even replacing lectures with active, group learning that involves discovery through solving hands–on problems. In fact, we use real problems from the companies in our research park. These approaches encourage students to take greater responsibility for their own learning as they take turns serving, within their groups, as manager, data analyst, recorder, and blogger. These changes can be difficult for students who prefer to work independently or want to passively attend lecture courses, but we have found that they learn more by working in groups, and that this approach better prepares them for careers in which they will likely need to work in teams.

We, in academia, often base decisions on anecdotal information as opposed to making data–driven, evidence–based decisions. The kind of culture change reflected in course re–design and other innovations begins by identifying a problem, and it continues through the process of collecting and examining relevant data. It is furthered by engaging stakeholders – students, faculty, and staff – in conversations about the problem, the data, and possible solutions, and it succeeds as we develop a common understanding of the problem and agree to a solution that reflects our values and the data.

Understanding the data is critical. We have built an evaluation component into our initiatives so that we can understand whether they are succeeding and what we might do to change course, if needed. We also use data analytics at the course and student level, to explore and assess overall performance trends and also to identify students who would benefit from early intervention. All of these approaches are important to improving student success.

Partnerships

As we work to increase the number of students succeeding in STEM, we must also ensure that we are effectively connecting students with internships, jobs, and careers. Partnerships are central to this. On our campus, we are partnering with other colleges

and universities, government agencies and laboratories, and companies. In this way, we can play a stronger role in an "ecosystem" encompassing education, training, internships, hiring, research, and technology commercialization.

Our partnerships with corporations are valuable and multi–faceted. The defense industry leader, Northrop Grumman, for instance, is supporting our students in cyber–security. We have partnerships with start–ups and smaller companies, including over 100 biotechnology and IT companies on campus in our research park. These partnerships provide students with internship opportunities, contributing to their overall education and their development as professionals while also helping them establish the networks that will get them jobs. Students often ask, "How am I going to use what I'm learning?" Giving college students a chance to work in cyber–security or biotech labs provides an answer to that question.

It is critical that we focus on the skills people need in order to be effective. Are we educating engineering, computing, and science majors who communicate effectively, who know how to work in teams, and who can put their knowledge and skills to productive use? Sometimes my humanities majors who take a few computer science or information systems courses go up the ladder in tech careers faster than our technology majors because they know how to speak and write well, and how to work effectively with people.

This is where companies can help. We need more connections and better communication between our faculty and their corporate counterparts. It helps our faculty to listen to companies to understand the skills that employees need and understand how graduates are faring after they are hired. What can we do to better prepare them for the work, for their first jobs, and for their careers in the long–run?

Professionals serve as excellent mentors for STEM students, guiding them through their studies and helping them navigate their way to jobs and careers. Students profit from having all types of mentors, including men and women and people from all social and other backgrounds. Mentors can emphasize to students that while the work is often hard, they will do well if they persevere.

We believe in multilevel partnerships. It enriches the academic environment for faculty and students to work collaboratively with researchers in companies on corporate projects. It strengthens our curricula for professionals from national agencies and companies to sit on advisory committees. Their advice and suggestions are invaluable.

Success is Never Final

U.S. News and World Report has ranked UMBC #1 in its annual list of "up and coming national universities" each of the past six years. Someone joked that eventually we should actually "arrive." But I tell people on my campus that we need to be careful about that. The moment you arrive is the moment you stop innovating. Redesigning courses and strengthening partnerships are two steps along the road to changing our culture and improving student outcomes, but we need many more. Success is never final.

About The University of Maryland, Baltimore County

The University of Maryland, Baltimore County was born amid the turbulent swirl of the 1960s, and had to cut her own path in a field of older, established institutions. From the beginning, UMBC believed that a university could be innovative, interdisciplinary, inclusive – and great. UMBC believed that groundbreaking research and a relentless focus on undergraduate success could go hand–in–hand. To this day, UMBC's faculty, staff and students work and create, outside traditional structures. It's not happenstance that UMBC had the first university research park in Maryland, dedicated to growing ideas into thriving businesses.

UMBC is a dynamic public research university integrating teaching, research, and service to benefit the citizens of Maryland. As an Honors University, the campus offers academically talented students a strong undergraduate liberal arts foundation that prepares them for graduate and professional study, entry into the workforce, and community service and leadership. UMBC emphasizes science, engineering, information technology, human services and public policy at the graduate level. UMBC contributes to the economic development of the State and the region through entrepreneurial initiatives, workforce training, K–16 partnerships, and technology commercialization in collaboration with public agencies and the corporate community. UMBC is dedicated to cultural and ethnic diversity, social responsibility, and lifelong learning.

About the Author

Dr. Freeman A. Hrabowski, III, has served as President of UMBC (The University of Maryland, Baltimore County) since 1992. His research and publications focus on science and math education, with special emphasis on minority participation and performance. He chaired the National Academies' committee that produced the recent report, *"Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads."* He also was recently named by President Obama to chair the newly created President's Advisory Commission on Educational Excellence for African Americans.

In 2008, he was named one of America's Best Leaders by U.S. News & World Report, which ranked UMBC the nation's #1 "Up and Coming" university the past five years (2009–13). During this period, U.S. News also consistently ranked UMBC among the nation's leading institutions for "Best Undergraduate Teaching" – in 2013, other universities on the list included Duke, Cal–Berkeley, Princeton, and Brown. TIME magazine named him one of America's 10 Best College Presidents in 2009, and one of the "100 Most Influential People in the World" in 2012. In 2011, he received both the TIAA–CREF Theodore M. Hesburgh Award for Leadership Excellence and the Carnegie Corporation of New York's Academic Leadership Award, recognized by many as the nation's highest awards among higher education leaders.